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ABSTRACT

This report describes a program for increasing class achievement by raising the motivational level of adolescents. The targeted population consisted of high school mathematics students from a metropolitan area located in central Illinois. The problem of low motivation level found in the targeted students was documented by student surveys. Evidence of this problem was also reflected in a high dropout rate as noted in the school's report card. The analysis of probable causes revealed that the students' lack of motivation was possibly caused by poor past performances, boredom, and a missing sense of ownership and responsibility. The attitudes of both students and parents continued to contribute to this problem. The presentation of inappropriate levels of task difficulty and a non-stimulating classroom environment has also fostered low motivation. Possible solution strategies involved a threefold approach. The first intervention targeted the students in an attempt to raise their level of intrinsic motivation and to increase their sense of ownership and responsibility. This treatment plan included student journals and surveys. The second intervention targeted the interest level of the students in the classroom. Collaborative groups and the use of multiple intelligence activities increased the motivational atmosphere. The third intervention targeted the classroom presentation by incorporating strategies such as writing through mathematics and solving real-life applications. The teachers' personal reflective journals indicated that progress was made in this area. Post intervention data indicated that cooperative learning and Multiple Intelligences (MI) activities did enhance the students' motivation for learning mathematics. Teacher and student journal reflections added a metacognitive element to this intervention. Appendices include the student survey and classroom materials. (Contains 73 references.) (Author/WRM)

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INCREASING STUDENT MOTIVATION THROUGH COOPERATIVE LEARNING, WRITING IN MATHEMATICS, AND MULTIPLE INTELLIGENCES

ED 436 351

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An Action Research Project Submitted to the Graduate Faculty of the School of Education in Partial Fulfillment of the Requirements for the Degree of Master of Arts in Teaching Leadership

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This report describes a program for increasing class achievement by raising the motivational level of adolescents. The targeted population consisted of high school mathematics students from a metropolitan area located in central Illinois. The problem of low motivation level found in the targeted students was documented by student surveys. Evidence of this problem was also reflected in a high dropout rate as noted in the school's report card.

The analysis of probable causes revealed that the student's lack of motivation was possibly caused by poor past performances, boredom, and a missing sense of ownership and responsibility. The attitudes of both students and parents continued to contribute to this problem. The presentation of inappropriate levels of task difficulty and a non-stimulating classroom environment has also fostered low motivation.

Possible solution strategies involved a threefold approach. The first intervention targeted the students in an attempt to raise their level of intrinsic motivation and to increase their sense of ownership and responsibility. This treatment plan included student journals and surveys. The second intervention targeted the interest level of the students in the classroom. Collaborative groups and the use of multiple intelligence activities increased the motivational atmosphere. The third intervention targeted the classroom presentation by incorporating strategies such as writing through mathematics and solving real-life applications. The teachers' personal reflective journals indicated progress was made in this area.

Post intervention data indicated that cooperative learning and Multiple Intelligences (MI) activities did enhance the students' motivation for learning mathematics. Teacher and student journal reflections added a metacognitive element to this intervention.

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CHAPTER 1

PROBLEM STATEMENT AND CONTEXT

General Statement of the Problem

Targeted students for this study are high school students enrolled in middle track mathematics who exhibit lack of motivation in academic areas. This problem affects class achievement which has an impact on our school's graduation and dropout rate. Evidence for the existence of the problem is documented by student surveys, student journals, teacher anecdotal records, and the school report card.

Immediate Problem Context

The targeted school is located in central Illinois and is a high school district encompassing 95 square miles. It offers a comprehensive educational program for grades 9 through 12 for students from seven feeder schools. The school is a split campus facility with freshmen and sophomores at West Campus and juniors and seniors at the East Campus. Approximately a mile and a half separates the two campuses. In conjunction with East Campus, there is a technical education center offering a complete vocational program for the students. Each campus includes a library, a media center, and computer labs. At the present time, a new addition to East Campus is under construction and in the fall of 1998 the school will be consolidated as one campus including a new pool.

Total enrollment according to the 1996 School Report Card is 2,419 with the following racial/ethnic diversity:

White	99.1%
Mexican-American	0.4%
Black	0.3 %
Asian/ Pacific Islanders	0.2%

Twelve point three percent of the students are from low income families. The average attendance is 92.1% while the dropout rate is 7.7%. Student mobility is 6.4% and truancy is 1.6%. The average class size is 20.7 students and the graduation rate is 69.4%.

The general school program offers an extensive array of courses for the diverse career paths of college, trade/technical school, military, or the world of work. Course offerings are available from the departments of English, mathematics, science, social studies, vocational education (business, industrial arts, and family and consumer science), cultural studies (art, music, and foreign languages), physical education, health, driver education, Jr. ROTC, and special education. Alternative school is an option for at-risk students. Also available to students is a variety of extra-curricular activities such as sports, clubs of varying interests, drama, show choir and music ensembles, and community service organizations.

The students are also serviced by a support staff consisting of seven counselors, three deans, one social worker, one school psychologist, a CARE team staffed by teachers and counselors, and various student support groups.

There is a total of 114 teachers on the faculty. Of these teachers 98.2% are White, 0.9% are Black, and 0.9% are Asian/Pacific Islander. Males account for 42.1% and females make up 57.9%. Average teacher experience is 19.1 years with 67.8% holding a bachelor's degree and 32.2% a master's degree. The average teacher salary is $39,496; the average administrator salary is $64,755. The pupil/teacher ratio is 21.7 to 1; pupil/administrator ratio is 302.4 to 1. Operational expense per pupil is $5,295 (1996 School Report Card).

Surrounding Community

The targeted school district serves an agricultural and industrial area, nestled on the Illinois River 70 miles south of the population center of the state. One fifth of America lives within 250 miles of the metropolitan statistical area of which the district is a part (*Peoria Journal Star* Market Report, 1994). The community itself has a population of approximately 33,000 according to the 1995 Census Report. Of that number, 98.82% are Caucasian, 0.16% are Afro-American, 0.17% are Asian/Pacific Islander, and 0.44% are Hispanic (The 1990 School District Data Book).

The median family income is $31,533, with a per capita income of $12,246. Poverty is of concern to community residents because 7.4% earn less than $5,000 per year; 11% earn $5,001 - $9,999; and 12.2% earn $10,000 - $14,999 (1992 Census Report). Approximately 12% of the working population is employed by a major industrial conglomerate, and another 15% work in outsourcing or supplying that manufacturer. A long history of labor disputes between the company and its unions is a continuing source of community concern. Local downsizing heightens economic anxiety. Other major local employers are a nationally known insurance company, an electrical energy

company, the local hospital, the federal prison, and the school districts themselves (Charles H. Renner, Executive Director, Chamber of Commerce, personal communication, May 31, 1997).

The median age of residents is 34.7 years with 75.7% having high school diplomas and 10.5% having a bachelors degree or more (1992 Census Report). Sixty percent own their own homes and the median value of a home is $67,000. The total assessed valuation for the grade school is $220 million; for the high school, $275 million (Charles H. Renner, Executive Director, Chamber of Commerce, personal communication, May 31, 1997).

In addition to the two campus high school, educational institutions within the community include six primary (K - 3) buildings, two intermediate (4 - 6) buildings, two junior high (7 - 8) buildings, three elementary parochial buildings, and one facility for special needs students.

Community resources add depth to the educational opportunities in the district. A congressional research center provides hands-on government experiences to all community members, including programs specifically directed toward students. Since the east campus is adjacent to an extensive park district, the two bodies often share such facilities as an ice-skating arena, soccer, baseball and softball fields, and tennis courts.

Community support goes well beyond shared facilities. Both school districts are bolstered by active volunteers in classrooms, booster clubs, and extracurricular activities. Local businesses are generous with their services and products as well as monetary contributions to student incentive programs. Most notably, in 1995, the

community narrowly approved a $16.2 million referendum to fund construction necessary to unify both high school campuses on one site. Construction has already begun and is expected to be completed for occupancy by the 1998-99 school year.

National Context of Problem

"Motivation, a student's intent to learn, is one of the most important factors in successful accomplishment," reports Madeline Hunter (1982, p.11,). Most educators agree that student motivation has a great influence on the learning process (Hicks, 1997; Hunter, 1982). Jordan (1996) explains that the impact of research done by Howard Gardner is an attempt to raise the motivational level of all students especially those labeled in the school community as lazy or low achievers. Gardner's research and statistics reveal that students show a marked decrease in enthusiasm toward academic activities by fourth or fifth grade; this decrease is then followed by reduced motivation and lower academic progress (Jordan, 1996). It is a well-documented fact that Asian-American children are flourishing in the same schools where other students are failing. Why do many American learners fail while these Asian-American thrive in the same class under the same teacher? According to Yong Hwang of Louisiana State University, the Asian-American students' higher academic motivation is the compelling factor in better student motivation (1996). Paul Houston, President of the American Association of School Administrators, summarizes the problem by stating that the lack of academic motivation "is a crisis which will require a concerted effort to eradicate" (Watson, 1996). Since recent theories concerning motivation involve both personal and educational aspects, "teachers and schools are not completely responsible for their students' motivation, but neither are they powerless to affect it" (Hicks, 1997, p 18).

According to Watson, while other nations have seen their students' performance increase, America has seen a decline in the level of diligence among many of its students (1996). Albert Shanker, president of the American Federation of Teachers, has written numerous columns concerning the academic apathy that is pervasive among some students. Shanker argues that children will do only what is necessary to achieve desired grades (Watson, 1996). Dr. William Muloney, Calvert County, Maryland Superintendent of Public Schools, on reporting the results of a survey of the faculty in his school district, states that the number one complaint among the staff members who were surveyed was "the erosion of the student work ethic" (Watson, 1996). The 25th Phi Kappa Delta/Gallop Poll of public attitudes toward public schools(1993) shows that 4% of its respondents mentioned pupils' lack of interest, poor attitudes, and truancy as the biggest problems with which public schools deal. It also states that 54% of the respondents think that by the year 2000, increasing the high school graduation rate to at least 90% is a high priority goal (Elam, Rose, & Gallop, 1993).

Motivating students to work through their struggles in mathematics instead of avoiding the conflict is an important life learning lesson (Sutton, 1997). Too often, the natural course of events that a student will take starts out with a struggle in mathematical comprehension followed by a shallow understanding and an attitude that they just need to get by. The approach they use to fight the battle of confusion will teach them life long lessons. A student needs to be aware that at some point in their math education they will encounter a challenge that may seem beyond their abilities. They need to be taught that this struggle is natural and is nothing to fear. They must

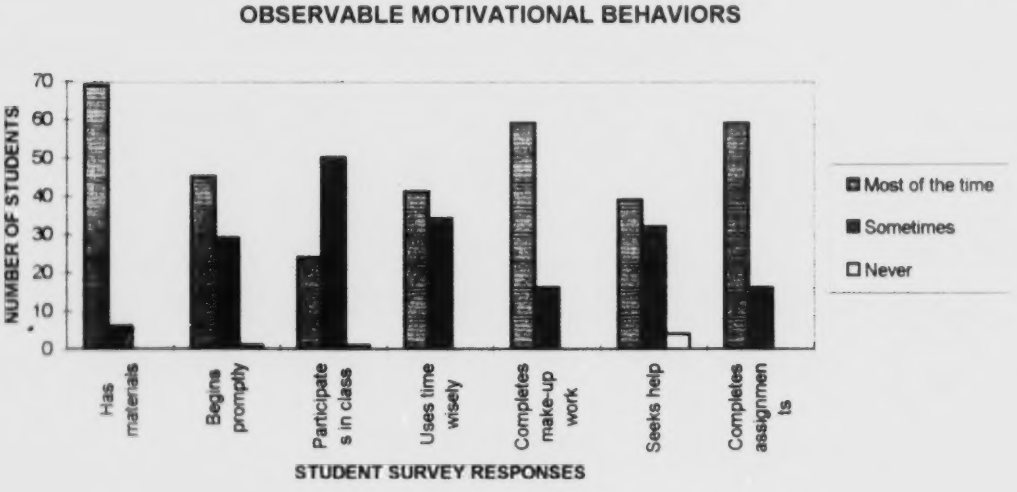
learn that the ability to attack any challenge lies within themselves. "How they approach the struggle of mathematics will affect how they approach the struggles they will encounter in life" (Sutton, 1997, p.52).

CHAPTER 2

PROBLEM DOCUMENTATION

Problem Evidence

To document the extent of lack of student motivation the researchers used a student survey (Appendix A) and a teacher checklist (Appendix B). On the first day of school, the student survey was given to all the students in the three targeted classes. Each teacher collected baseline data by completing a checklist of eight observable behaviors. This checklist was recorded daily for one week early in the semester.



GRAPH 2-1

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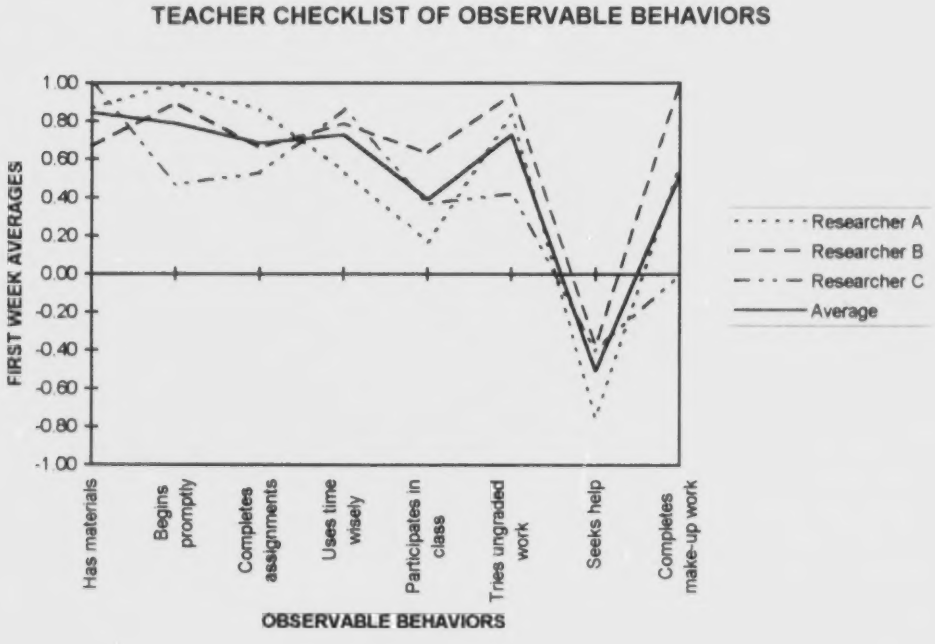
A summary of the student tallies is presented in GRAPH 2-1. Of the 75 students surveyed, the bars represent the number of responses to questions pertaining to observable behaviors. The researchers noted that the majority of students reported that they did well on most of the motivational behaviors. However, the researchers believe this information is distorted by the optimistic attitude of the students on the first day of school. This survey indicates that the students know they do not participate in class frequently. From experience, the researchers believe this lack of participation can be due to the lack of confidence, apathy, or disinterest in the subject matter.



GRAPH 2-2

GRAPH 2-2 compares the data collected by the three teachers. Teachers A and C each chose eight or nine students from a middle track junior level geometry class.

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Teacher B chose eight students from a middle track senior level trigonometry class. These targeted students were chosen randomly in each class.

The behaviors of the targeted students were recorded daily for one week early in the semester. The checklist incorporated the following rubric: -1 = not usually true, 0 = sometimes true, and +1 = usually true. However, due to the daily recording, the researchers decided that "sometimes true" was not an appropriate option. Each teacher averaged the +1 and -1 per behavior for the week. Each class average was compiled and reflected in GRAPH 2-2. The reader must be aware that because of the scoring system, the graph range is from negative one to positive one.

All three researchers discovered that the behaviors meriting extra attention are "seeks help" and "participates in class". Therefore, we targeted our action plans to address these concerns.

PROBABLE CAUSES

Literature Review

"Motivation is the willingness to expend a certain amount of effort to achieve a particular goal" (Redick, 1991, p.23). Psychologists, behaviorists, humanistics, cognitists, and educators all interpret this definition of motivation differently. To help understand student motivation, a quick summary of the recent theories and terminology involved will first be reviewed.

Throughout time, theorists such as Plato, Socrates, Freud, Skinner, Deci, Bandura, Weiner, and Zimmerman have written about human motivation (Hall, 1982; McCombs 1991). In the field of psychology, motivation is viewed as a perception that cannot be directly measured because it involves a person's past, present, or future behavior in a

given environment (Hall, 1982). The behaviorists emphasize extrinsic motivation, the humanists stress intrinsic motivation, and the cognitists accentuate an individual's understanding and knowledge in addition to intrinsic motivation (Redick, 1991). In education, the definition of motivation includes the personal and environmental factors along with the sources of intrinsic and extrinsic motivations (Redick, 1991). Sociocognitists go one step farther to include volition (the follow-through) with motivation (the commitment) as influences on students' response to schoolwork (Corno, 1992). Snow (1989) states that modern theories of learning consider the broad range of student aptitudes, their cognitive abilities, and the learning environment as important factors that affect school performance (Corno, 1992). In the last 25 years, the theories about student motivation include the themes of attribution, achievement, self-esteem, and anxiety. Inherent in each of the themes is again the ideas of intrinsic and extrinsic motivation.

Extrinsic motivation is based on factors that are external or unrelated to the activity such as rewards, punishments, and incentives (Spaulding, 1992; Redick, 1991). This type of learning is dependent on the teacher's entertainment factor or on the classroom environment, not on the student's attitudes, abilities, or goals. The student is not self-regulated but is concerned with "self-protection and academic survival" (Ridley, p36). Dweck's (1975) studies indicate that students, using mainly external factors of motivation, are helpless learners who give up easily when frustrated or tired (Hall, 1982). They only learn when reinforcement is present, may become dependent on the teacher, and may eventually consider the teacher too controlling (Redick, 1991).

On the other hand, intrinsic motivation involves the inner desire to accomplish a task successfully based on personal growth and fulfillment (McCombs, 1991; Spaulding, 1992). The sociocognitists use the term, self-motivated, referring to the "self-efficacy perceptions and use of self-regulatory processes during learning" instead of intrinsic motivation. Both terms describe "a willingness of self-regulated students to continue to practice or study in the absence of direct external control by parents or teachers" (Zimmerman, 1994, p. 11). Theorists who use the phrase, self-regulated learning, include motivational (goal-setting) and volitional (goal-protecting) behaviors in their writings. "Self-regulated learners understand their thoughts and emotions enough to regulate or control them while learning, just as they adopt appropriate goal and attitudes and take responsibility for completing and evaluating their work" (Corno, 1992, p. 74).

The personality of the present day student can be a factor that could possibly lower the motivational level. Too many students have the "Let's just get by" attitude (Ridley). They will put forth as little effort as possible to do the required work. A low-achieving student feels "smart" when he or she can easily perform a task and this sense of "smart" is threatened by difficult or challenging material (Rimm, 1997). These students are much more interested in the social aspect of school. They view the school environment as a place to get together with friends and not a place to learn. Rather than spending class time working on assignments, these students would rather visit with a classmate or read a magazine (Bacon, 1993). Students are lacking internal motivation. As a result, what little motivation they muster up comes from external stimuli such as the teacher's ability to make the class exciting, fewer distractions in the

classroom, and the period of the day the class is offered (Ridley). Any failure that might result from this lack of effort is easily blamed on others.

The typical present day math student views his mathematics class as a "rigid system of dictated rules governed by standards of speed, accuracy, and memory" (National Academy Press, 1989). In this society that glamorizes violence and makes hate a prevalent emotion, the "I hate math" movement is a dominant force in the classroom (Datta, 1993). The early childhood enthusiasm for math turns to apprehension and past confidence turns to fear (National Academy Press, 1989). Mathematics is considered to be the curriculum that is most likely to turn students away from the subject and possibly away from school itself. United States children consistently fall behind other highly industrialized countries in math achievement (Garden, 1987 as cited by Uttal, 1996). Potential factors in this lack of achievement are poverty and student home life (Schoen & Hallas, 1993). As a result of fragmented home environments, responsibilities formally handled by parents are now assigned to schools (Hwang, 1995).

Parental attitudes are also a contributor to unsatisfactory student achievement. Parents excuse their child's poor performance in mathematics by blaming failure on a lack of innate ability. This belief that math performance is contingent upon genetics undermines three very important attitudinal traits needed to succeed: practicing diligence, completing homework conscientiously, and willingness to learn from mistakes (Uttal, 1996). Too often, the comment is made from adults "I was never any good at math". It is socially acceptable in the United States to perform poorly in math. On the other hand, the drive to wipe out illiteracy has shown that it is not socially acceptable to

be a poor or non-reader. Research has confirmed this idea that American parents consistently rate reading progress as more important than math progress (Stevenson & Stigler, 1992, as cited by Uttal, 1996).

Parent apathy toward mathematics is soon assimilated by their children. To counteract this attitude, the schools have overreacted with praise and rewards. American children are spoiled and think they need to be praised and rewarded by their teachers for even minimal accomplishments (Hwang, 1995). American culture stresses the need for constant and immediate gratification. This culture also glamorizes the easy road to success and living life in the fast lane. The easy way out is the path usually taken and students that do show an interest in academic pursuits are often ridiculed and referred to as nerds (Hwang, 1995).

Is failure the result of lack of effort or low ability? While American culture dictates the answer to be low ability, Asians would believe that failure is a result of lack of effort. Asian culture emphasizes effort. Increased effort will result in increased academic achievement that will ultimately produce success in school. So if a failure occurs, failure is blamed on the lack of effort on the student's part or on the parent who possibly neglected to prepare their child adequately. Unlike in American society, the school and the teachers are not blamed for the failure. Success in academic achievement is not looked upon as a personal triumph but as an obligation to bring honor to the family. Asian children are not given unlimited praise. Success is usually acknowledged with parental encouragement to strive higher and farther. The result is that Asian children consistently outscore their American counterparts (Hwang, 1995).

Americans tend to run away from responsibility and blame failure on anyone or anything that may cross their path. Hwang explains this philosophy as the "age of the victim". "If a child fails, society is at fault, poverty is at fault, teachers are at fault. Everybody is responsible except the student who failed and parents themselves who failed to motivate the learner" (Hwang, 1995, p. 488). This victim mentality is the root of many problems in American education. Schools are debilitated when every failing child is a victim (Birnbaum, 1991, as cited by Hwang, 1995). Students are often blinded to their lack of responsibility. They see themselves as responsible learners even when they are failing (Bacon, 1993). These students view the classroom not as a place for learning but a work camp where they must accomplish a certain work quota to survive. Students feel they are "being held responsible" which translates into the image of individuals only doing the required work when the guard (teacher) is standing over them. The ideal scenario on the opposite end of the continuum would be to move the students into the realm of "being responsible" which means work ethics would be driven by an internal motivation (Bacon, 1993).

Another factor to consider in the analysis of low student motivation is the concept of self-efficacy or the student's opinion of his ability to successfully complete educational tasks. A major detriment to self-efficacy is the student's perception of low ability (Schunk, 1984). In the competitive society that the students must perform, failure designates a person to be a "loser". Therefore, a student who perceives himself as possessing low ability would rather not even attempt the task to avoid any chance of failing or losing (Covington, 1991). This student might miss choice opportunities because he might believe himself incapable of the task (Spaulding, 1992). Research

has shown that perceived competence is a stronger indicator than actual competence of a person's ability to successfully complete an educational experience (DiClemente, 1981 as cited by Spaulding, 1992).

Teachers' prejudices also contribute to a student's lowered sense of self-efficacy in conscious and unconscious attitudes. A teacher who views a student as incapable will send out cues to let the student know that his teacher is expecting a poor performance. Examples of negative signals are consistently assigning the easiest problems to the "poor" students to work out on the board. Also, this type of student will typically be assigned a more competent partner to help him learn the material (Spaulding, 1992). A student's lowered perception of his ability to perform a task is directly correlated with a decreased sense of possessing control. Actions by the teacher that contribute to this feeling of loss of control are closely monitoring behavior and academic progress, enforcing completion deadlines, and emphasizing the teacher's role as an evaluator over the instructional role (Spaulding, 1992). The result of these negative components operating in the classroom is frustration. The student is frustrated because he feels incapable of doing the work and lacks control input into the activity. The resulting student behavior could either become passive or disruptive, both of which cause major frustration on the part of the teacher (Bacon, 1993).

Another component missing in a low achieving student is the ability to self-regulate. Good students use self-regulation to set goals, employ effective learning strategies, resist distractions, and motivate themselves to successfully complete a task (Zimmerman, Bandura, & Marinez-Pons, 1992). A poor student lacking in this ability only uses a minimal number of learning strategies that will have to suffice for any

variety of learning content. This student does not take advantage of the feedback he receives in a learning situation. Poor grades and teacher feedback have little effect on the non-reflective student. Thus, he misses the opportunity to explore his attitudes, abilities, and goals, a process that would increase his life-long learning process (Ridley).

Student boredom with mathematics, a definite cause of lack of motivation, often results from a traditional teacher lecture presentation (Carlin, Ciaccio, Sanders, & Kress, 1997). The least effective mode for learning math is lecture. Lecture and repetition help students do well on standardized tests and lower level skills but are generally ineffective as teaching strategies for long-term learning, higher-order-thinking, and for motivating a love for mathematics. When teachers plan activities that include novel events, situations, and materials, students are more likely to be motivated to learn (Redick, 1991). National Council of Teachers of Mathematics (NCTM) standards believe that learning math requires students to share, question, challenge and explore mathematics together (Grouws and Lembke, 1996). To accomplish this social dimension of education, teachers must become facilitators rather than lecturers.

Redick and Vail note that a classroom is a social situation with a power structure, including peer relationships, as well as adult-child relationships (Redick, 1991). Hence the most favorable motivational conditions need to take both of these social relationships into account.

Marshall's (1987) observations of three fifth grade teachers revealed that students were more likely to stay on task if the teacher intrinsically motivated them in comparison with students whose teachers extrinsically motivated them (Newby, 1991).

The type of classroom reward structure that a teacher selects can encourage or discourage motivation. For most classroom tasks, competitive reward structures discourage motivation and achievement while collaborative and individual reward structures can enhance motivation and achievement (Redick, 1991).

Teachers have been perplexed and fascinated by students who perform poorly in math class and appear unmotivated - yet outside the classroom these "underachievers" would be seen with their faces lit with laughter and enthusiasm for whatever they were doing. Why can't math teachers bring this out of them in class? Bussey (1992) wrote "too many kids are flunking out of Algebra 1 or getting turned off to mathematics. Isn't there more than one way to learn math?" (Alper, Fendel, Fraser, & Resek, 1996). According to Redick and Vail, the type of learning tasks that teachers set do affect motivation (Redick, 1991). Since today's student is wired for stimulation, he is not at ease with peace and quiet (Natate, 1995). Students must be actively involved in their learning (Grouws and Lembke, 1996). A curriculum based on memorizing facts does not involve the students. Such a curriculum is perceived by students as irrelevant to their lives (Carlin, Ciaccio, Sanders, & Kress, 1997). Math would be far more interesting to students if they could do some real thinking (Alper, Fendel, Fraser, & Resek, 1996). It is time to minimize rote learning and concentrate on teaching children how to think.

CHAPTER 3

THE SOLUTION STRATEGY

Literature Review

> Almost every math teacher will agree on the importance of proper motivation for the teaching of mathematics. Students, except for the very few who seem to have a natural love for the subject, need to have their interest stimulated through suitable teaching techniques and procedures. Only by doing so can we avoid problems such as math anxiety, which has become so prevalent in recent years (Solbel & Maletsky, 1988, p. 27).

Solutions to the lack of student motivation cannot be based solely on learning laboratory findings since the personalities of the teacher and the students are involved. The classroom is a social structure with peer relationships and teacher-student relationships. Therefore, both the teacher and the students must be involved in the process of building academic motivation in the classroom. First by using appropriate teaching strategies, the teacher needs to set the tone of the learning environment by selecting suitable tasks, by dispensing the correct mixture of intrinsic and extrinsic rewards, and by displaying a caring attitude. Then the students' self-efficacy, self-responsibility, and attitudes about their skills and abilities need to be considered as

factors in motivation. So a primary goal of any teacher is to develop the strategies to encourage the motivation to learn so that the students "feel confidence in their abilities to improve, value the tasks of learning, and stay involved in the process without being threatened by fear or failure" (Redick, 1991 p. 25).

John Egsgard, President of the National Council of the Teachers of Mathematics (NCTM) in 1976, defined a good math teacher as "one who uses his knowledge of math as well as his love and respect for his pupils to lead them to an enjoyment of the study of mathematics" (Datta 1993). Many new mathematics teachers try to live up to this definition. All teachers who are concerned about their students' academic motivation would be well advised to take the time to reflect on how their style of relating to students helps to shape their students' motivation level in the classroom (Spaulding, 1992). Research has shown that teachers do influence the motivation level of their students (Newby, 1991, Redick, 1991). Ames and Ames (1984), for example, suggest that the teacher goals and values set forth in the classroom strongly impact task motivation (Newby, 1991). Math teachers must build positive relationships with students by showing interest and concern for them. Teacher-student relationships characterized by mutual respect and trust seem to be the ones that are most likely to nurture academic achievement (Spaulding, 1992).

When students were surveyed, they indicated that a teacher should be "fun, caring, devoted, patient, intelligent, a role model, expressive, and personal" (Firestone, 1989). So to fulfill these requirements, a teacher must first establish an atmosphere in the classroom that is supportive, encouraging, friendly, respectful, trusting, and focused on learning (Redick, 1991; Grouws & Lembke, 1996). Potsdam State College (in the

economically depressed northeast corner of NY) has possibly the greatest percentage of math graduates of any public institute in the country - close to 10 %. The most important difference between the Potsdam environment and other schools is the teacher concern for students according to the Mathematics Department Chair, Stephens. He believes that if students know their teacher cares for their well-being, they will respond well to the mathematics that the teacher is trying to teach (Datta 1993). The teacher should become acquainted with the students as soon as possible, show genuine concern for them and their interests, be accessible for help, promote the students' belief in themselves, and maintain a calm, predictable climate for learning (Spaulding, 1992; Redick, 1991). Appropriate teaching strategies then need to be developed which take into account the students' beliefs, attitudes, and emotions (Schoen & Hallas, 1993). Teacher-student interactions, both in and out of the classroom, are an easy way to transmit a message of caring (Redick, 1991; Spaulding, 1992). Opening up the lines of communication will then make the implementation of other strategies easier. For example, assessing students' attitudes and beliefs through a questionnaire or discussion at the beginning of a new topic gives the teacher and the students a common starting point for the new material, helps to point out common fears and differing perceptions, and reveals information upon which the teacher can make the lesson more relevant. This is one way a teacher can reach students by using "a combination of self-awareness and motivational tactics" (Ridley, p. 45). Once easier communications are established, the teacher can concentrate on using other teaching strategies which are intertwined with the needs of the students.

The teacher has to consider numerous factors when planning classroom activities. Findings indicate that teachers must make evident that learning is the main reason for school, must share the responsibility of learning with the students by creating meaningful experiences, and must make schoolwork challenging (Bacon, 1993). Hamachek (1973) states that "well-prepared, well-presented lessons, exercises that are within the grasp of the learner but not too easy, variety of experience--in other words, good teaching generally--affect students so that they want to learn" (Hall 1982, p. 1261). According to the constructivists, the facilitator has the responsibility for creating an appropriate learning atmosphere where the student is an active worker (Steffe & Wood, 1990, & Von Glasersfeld, 1989, as cited by & Schoen & Hallas, 1993; Corno, 1992). A recent survey indicates successful teachers believe that requiring student participation and serious attention to math is important for effective learning (Sosniak & Ethington, 1994). So to make learning meaningful and to encourage participation, a teacher must employ an assortment of teaching and motivational strategies and aides such as an overview of lectures, graphic organizers, cooperative groups, modeling, technology, manipulatives, paired-problem solving, writing assignments, whole class discussions, supervised practice, or projects (Spaulding, 1992; Silver, Kilpatrick, & Schlesinger, 1990; Kornbluth & Sabban, 1982, & Shade, 1982, as cited by Schoen & Hallas, 1993). Since students' attention span may only be 15 to 20 minutes long, a variety of these motivational techniques should be used continually, consistently, and genuinely to ensure success (Grouws & Lembke, 1996; Spaulding, 1992).

than one right answer, that students should seek solutions instead of memorizing procedures, and that students should explore patterns not memorize formulas (National Academy Press, 1989). To help create this type of environment, teachers should present lessons clearly and enthusiastically by encouraging inquiry and communication and by incorporating such teaching ideas as probing questions, relevant examples or applications, and wait time (Sipka, 1990; Spaulding, 1992). According to Tobin (1987), a study shows that a wait time of three or more seconds does improve students' ability to reason (Schoen & Hallas, 1993). In addition, the teacher should vary the modes for direct instruction by utilizing lecture, question and answer time, demonstrations, lab activities, and practice time. Manipulatives then can be used to enhance a demonstration or an activity (Schoen & Hallas, 1993). To engage the learner, blackboard recitations can sometimes be used. These have a twofold purpose: to help other students understand more about a problem and its solution and to give the teacher a chance to view the students' thoughts, reasoning, and understanding (Silver, Kilpatrick, & Schlesinger, 1990).

Many school practices today rely on extrinsic motivators such as grades, stickers, praise, extracurricular eligibility, or punishments to promote learning. A teacher needs to show students how to rely less on extrinsic and more on intrinsic motivators (Spaulding, 1992). To accomplish this, the facilitator can raise the students' level of concern, improve their attitudes, and increase their feeling of success by monitoring the level of task difficulty and by using a variety of teaching techniques. Also the teacher can increase the level of interest in the subject by relating the material to the students' lives, making novel and interesting presentations, by giving appropriate feedback to the

students, and by using a correct balance of extrinsic and intrinsic motivators (Hunter, 1982). According to Ames (1992), besides using these various teaching techniques, the teacher must also create challenging but attainable learning goals for students so that they may see success as they are developing their learning and math skills, expanding their knowledge, and gaining understanding (Collopy & Green, 1995; Spaulding, 1992; Redick, 1991). Teachers can then use their communication skills to help students learn to attribute success to effort and ability and ascribe failure to lack of effort (Collopy & Green, 1995; Hall, 1982). The students can keep records to stress self improvement, not competition with others (Spaulding, 1992). All of these approaches to learning help to instill a sense of intrinsic motivation, independence, self-confidence, and self-responsibility within each student (Grouws & Lembke, 1996; Datta, 1993).

Feedback is another way that teachers can encourage the growth of intrinsic motivation. Correctly worded feedback can help students learn to be more competent and can help them to improve. Deci (1975) states that feedback can be either extrinsic, as general praise and rewards, or intrinsic, specific information. Excessive praise or rewards make students dependent on the teacher, not on themselves for gratification. Feedback should be related to the task, should acknowledge good independent behavior but not conforming behavior, and should be informative but not controlling (Spaulding, 1992). Motivation will increase if students are given specific, immediate knowledge of the results of their performance (Spaulding, 1992; Redick, 1991). This feedback should include precise comments on what was done well, what needs

improvement, or how to improve the assignment. Also to motivate students to complete the task, these statements should be carefully phrased showing the students that they can succeed with improvement (Hunter, 1982).

Writing in mathematics is a powerful communication tool that can be used for such purposes as developing a language for questioning, for organizing material in a student's own words, for providing immediate feedback, for breaking down student fears, for helping students to become self-regulated, and for enhancing the intrinsic value of math (Keith, 1990). When students explain a concept or a definition in their words, it forces them to recognize the extent of their understanding. Then as they reflect on their thoughts, they can integrate this knowledge with other facts or problems and draw further conclusions. So a facilitator can assign writing to increase understanding, to build knowledge, or to increase comprehension of a topic (Keith, 1990). These writing assignments can also add variety to a lecture-oriented class, can improve a student's writing skills, can help them be autonomous learners, and can provide an accurate assessment of a student's level of understanding (Sipka, 1990). Some writings can be targeted to accomplish specific goals. For example, Gibson (1994) asked the students to complete the metaphor, "Math is like a ....", at the beginning and end of each semester to first gain some insight into the students' feelings about math and then their growth in math. Instead of leaving a problem on a homework assignment blank, Standera (1994) had the students articulate on why they could not do the problem. She found that this technique made them accountable for the whole assignment, made them learn to solve problems through writing, and made them more independent and responsible. She then would use these comments as a

basis for discussing the homework which showed that the comments were valued. Standera also had the students verify some of their work in writing to give them a sense of ownership and pride and an opportunity for some creativity. Similar to this idea, another teacher sometimes asked the students to explain a problem or summarize a section of a chapter in writing as if talking to a friend on the phone (Keith, 1990). Some teachers use the last five minutes of class time to have students write on such topics as "What I learned today is ..." or "What I still have questions about ..." (Silver, Kilpatrick, & Schlesinger, 1990) These writings can become a non-threatening tool for student-teacher communication if students are encouraged to write honestly and freely (Ehrich, 1994).

Writing, however, emphasizes only one of Gardner's seven intelligences, the verbal/linguistic. By exposing and discussing all seven intelligences, teachers can make students aware that many different intellectual abilities are required by some collective tasks and that no one has all but that each person has some of the seven intelligences (Bracey, 1995). Ellison, a teacher who uses multiple intelligences in her classroom, notes that "as (her) students internalize the many forms of intelligent behavior, they broaden their respect for the diversity of abilities within our classroom" (1993). By discovering the hidden talents in the classroom, a facilitator can increase the level of participation of a low-status student or could help reach some students who had been previously overlooked (Bracey, 1995; Nelson, 1995). To accentuate different intelligences, teachers may invite guest speakers who talk about an intelligence and their professions or have the students do projects or videos using a chosen intelligence.

The use of projects and games in the classroom may incorporate many of the seven intelligences and the love of math. "Mathematic recreations can serve as a very effective means of motivation at almost all levels of instruction and for students of varying levels of ability" (Sobel & Maletsky, 1988, p. 73). They can also add variety to the daily routine, engage the students in active learning, and address students' social needs (Hootstein, 1994). These projects allow the students a chance to make their own decisions which give them a sense of self-control which may sometimes reduce anxiety (Spaulding, 1992). Two drawbacks noted by teachers concerning projects are the lack of time for planning and organizing them and the source of money needed to supply the additional materials (Hootstein, 1994). To incorporate many intelligences, students should be given the options on how they acquire the information and how the knowledge is presented. A teacher may allow students to do some type of oral or written presentations to show their individuality. Technology such as the internet, video or audio taping, or computers could also be incorporated in any project or assignment to spark interest (DeMeulemeester, 1995).

The main problem of secondary schooling cited by Gallicchio (1993) is that yesterday's teachers are teaching today's students. The tremendous mismatch between the context for which teachers were prepared and have taught in for much of their careers and the realities of today's classroom has been underestimated. Based on surveys of 700 high school teachers in Michigan and California, these contexts have changed radically even in the last five years. Today's teachers must cope with dysfunctional lives of students which take precedence over schooling, their lack of interest in reading, an imbalance between part-time work and school work and lack of

support from families. The nation's educational goals will be met only if reform focuses on the interactions among teachers, students, and content (Gallicchio, 1993).

In 1991, Newby's investigations observed the use of three motivational strategies that address this focus: confidence building, relevance, and attention-focusing. Confidence building strategies focus on helping the students view the task as challenging but accomplishable. Examples include organization of materials at levels of increasing difficulty, attributing student success to effort rather than luck, and helping students set realistic goals (Newby, 1991). It is important for teachers to find a balance between easy and moderately challenging academic tasks. Students must have opportunities to demonstrate their existing competencies by engaging in relatively easy tasks and to develop new competencies by successfully completing moderately challenging tasks (Spaulding, 1992). Teachers working to enhance their students' intrinsic motivation should accept the failures that do happen in their classrooms and help students who do fail to recognize that their own efforts are the means toward success next time (Stipek, 1988; Weiner, 1986 as cited by Spaulding, 1992).

Grades also affect students' confidence, thereby affecting their motivation. Although many teachers and parents explicitly encourage students to strive for a "good grade," this generic goal is not very effective in motivating performance because traditional grading practices do not take into account students' starting points. Traditional approaches usually are ineffective in motivating students because the approaches do little to ensure that each student faces a goal that is reachable yet challenging. Most people consider surpassing their average previous performance to be a fair and reasonable goal. The Incentives for Improvement Program (field tested in several

Baltimore middle schools) and the Challenge Program (field tested in a Connecticut high school) both use students' average previous recent performance as the standard to beat; distribute feedback charts to students that show their attainment or nonattainment of various types of improvement goals; and provide recognition to all students who raise their performance levels across time (MacIver & Reuman, 1993/1994). Students in these programs performed two-thirds of a standard deviation higher on fourth quarter assessments than did students in the control classes. The two programs' evaluation confirmed that student effort and performance can be increased by a student accountability program that gives students specific improvement goals and provides them with recognition whenever they reach these goals (MacIver & Reuman, 1993/1994).

Relevance strategies emphasize answering questions such as "Why do I have to learn this?" or "What is the value of this?". First, provide students with a rationale that explains the purpose and importance of each learning activity. Make it real. Link it to the ideas and structures they are used to. Second, emphasize the value of each activity. Make it apply. Students should feel that they will use the math, not just down the road, but they could apply it today. Future success within the real world settings may be dependent on the acquisition of specific skills. Make these relationships explicit. Third, capture interest by pointing out inconsistencies between new information and prior knowledge. Get a grasp of what it is your students enjoy doing and adapt your lessons to their interests (Fulk, Montgomery-Grymes, 1994; Blackburn, 1995).

Attention-focusing strategies are those that not only focus attention but also sustain it by responding to the sensation-seeking needs of students (Newby, 1991). Examples include varying the medium of instruction, using humorous analogies, and turning off the lights to quiet the class.

Math teachers should vary the types of questions asked of students. Open-ended questions like: "What properties do prime numbers have?" should be created so that students can explore (Silver, Kilpatrick, & Schlesinger, 1990). Ask this type of question of collaborative groups so that the likelihood of getting started on a solution is higher. Teachers could have students create rather than answer a problem (Silver, Kilpatrick, & Schlesinger, 1990). If students are always presented well-formulated problems that contain just the information needed for a solution, how can they learn to deal with situations in which appropriate math ideas and techniques are not obvious? Fix-It-Problems can also add variety to a math teacher's repertoire. Given an incomplete problem, groups of students would try to come up with the best problem and solution (Silver, Kilpatrick, & Schlesinger, 1990).

Daily presentation of creative, interesting lessons can be time-consuming or even exhausting. However, any lesson format that is repeated on a daily basis is bound to become monotonous for both students and teachers. We, as teachers, need to employ a variety of instructional techniques including cooperative learning, peer-tutoring, hands-on activities, group projects, discussions, game formats, computer or calculator assisted instruction and other individual activities. We should encourage active student participation by saying "Jot down...", "Tell your neighbor...", "Respond in unison...", or "Signal agreement with thumbs up" (Fulk & Montgomery-Grymes, 1994).

Designing lessons is at the heart of what it means to be a teacher (Burrill, 1997). It goes beyond having a set of examples to illustrate a procedure. Building understanding depends on how we as teachers craft the experience, how we build on what students already know about the concept, and how we can draw out students' thinking to direct it toward understanding. Burrill (1997) reflects " I learned that I need to spend more time creating the scenario for teaching - to think about the tasks I select and the structure of the lesson." As we think about what we will teach, we must think about the mathematics we want our students to learn and whether lessons structured around group work, individual work, or lecture will enable that learning to take place.

Student interest can be stimulated when teachers make their lessons unusual. Using colorful props, providing opportunities to leave the room to work in different locations around the school, and singing definitions could all be examples of relatively unusual activities in the school life of most children. Unexpected events can also lead to a heightened level of student motivation . When students are confronted with a task for which a positive outcome is likely but not guaranteed, then they tend to have a heightened level of interest in the task (Spaulding, 1992).

The notion that students learn best when they are immersed in meaningful activities is a current practice in educational reform (Gitomer, 1994). Manipulatives in mathematics are attempts to have students experience mathematics in ways that are not possible through textbooks, drill, and didactic teaching. There is a growing recognition in schools that cooperative, as opposed to competitive, teaching strategies best enable children to learn (Wood, 1992). Cohen and Lotan explain "those who talk more, learn more" (Bracey, 1995). Slavin (1984) has argued that one factor influencing

the success of cooperative group instruction is the positive motivational impact of peer support for learning. When peers recognize that their rewards are dependent on the success of their teammates, they are more likely to provide emotional and tutorial support for learning. Ames (1984) has found that students' self-perceptions of ability increase following group success in cooperative learning activities.

Many secondary students view mathematics as a static body of knowledge compiled long ago, only marginally related to the real world (Gibson, 1994). There is another view of mathematics. It is a way of exploring and describing the world of nature and the world of imagination. In this view of mathematics, the role of the teacher is to help students uncover ideas. The role of the students is to be active learners, which requires using intuition, common sense, and insight; explaining; listening; asking questions; and clarifying. Active learners develop personal understandings of the concepts, appreciation for the power and beauty of mathematics, and confidence in their ability to learn. Bock (1994) finds that cooperative learning techniques enable him to help students obtain this view of mathematics (Gibson, 1994).

Learning occurs through involvement. This happens most readily when students work in collaborative groups, engage in discussion, make presentations, and in other ways take charge of their own learning (National Academy Press, 1989). According to Datta (1993), cooperative learning can change student views of themselves and of mathematics by: (a) taking away the boredom of listening to a lecture (b) allowing students to use the resources of each other in the learning process (c) bringing the material down to the level of the students' understanding instead of being presented at the level of the teacher's understanding and (d) introducing students to experiences

they are likely to encounter in the work world. Other benefits of cooperative learning are: (a) students develop better mathematics vocabularies (b) students learn to listen to other people's suggestions and questions (c) students become teachers themselves as they explain their ideas to others in their group and (d) students' base of experience broadens as they hear alternative explanations and see a wide variety of analytical approaches (Gibson, 1994). It has also been noted that when group work becomes a feature of the classroom, students begin to study together after class as well (Keith, 1990).

Teachers can make sure that cooperative learning is beneficial to students by doing the following: (a) include a group performance (b) explain to students why collaborative work is important (c) create diverse groups (d) listen in on group discussions and offer advice and (e) provide immediate feedback (Datta, 1993).

Collaborative learning has a place in the math curriculum because it fosters trust in groups which can aid in overcoming math anxiety. The group setting provides support and encouragement to students who lack confidence in their ability to do math (Kenney, 1990). However, cooperative learning, manipulatives, and technology are not a panacea. They will not end absenteeism, cure drug abuse, or turn your weakest student into a National Merit Scholar. They can, however, establish a framework for a greater variety of classroom activities, engage students in the learning process, and change their views of themselves and of mathematics.

The ideal in student motivation would be for an individual to have an unquenchable thirst for learning. It is vitally important to discover the roots of student interest. Does this interest stem from a certain lesson or does the interest come from within the child

himself? It is much more beneficial if the latter case is true (Middleton, 1995). Students' motivational level is influenced by their attitude. Their attitude is affected by a complex set of factors such as self-efficacy, self-esteem, self-reflection, responsibility, ownership, and control.

The student's sense of self-efficacy, which is the feeling that one is capable of completing the task, is increased when the student works at a task and experiences success. As success becomes more frequent, the student's motivational level rises (Schunk, 1984). Students will also enjoy a higher degree of self-efficacy if they can internalize the idea that past failures are the result of insufficient effort rather than any lack of ability on their own part. Adults can help bolster this increased motivational state by providing appropriate praise and effort feedback. Rewards are another tactic used to boost self-efficacy, but they must be genuinely given and reflect significant student accomplishments (Schunk, 1984). A social reward such as praise has been found to be more of a catalyst that will allow students to internalize parents' and teachers' values rather that external rewards such as money or prizes (Stipek, 1993). Deci (1971) has conducted research that has illustrated how these external rewards could actually attenuate intrinsic motivation (Stipek, 1993). The major contribution that self-efficacy plays in student attitudes is that if an individual appraises himself to be highly capable, then the valuable byproducts will by greater acceptance of challenges, better perseverance, and ultimately, higher achievement (Schunk, 1984). There is also a direct correlation between perceived ability and intrinsic motivation. The higher the success students feel capable of obtaining in a course, the higher they rate the interest

level of that particular subject, and consequently the more motivated they will be to complete assigned tasks (Stipek, 1993).

The ideas of self-efficacy and reward are the main components of the "X Value Theory" as researched by Feather, (1982), Good and Brophy, (1987), and Berndt and Miller, (1990). This theory suggests that student motivation is a product of two factors. The first factor is the self-efficacy component that is the part in which the student must feel capable of success. This is deemed the expectancy factor. The second factor named the value factor is contingent upon students visualizing the rewards that will come from their efforts to succeed. If either factor is missing, the result will be zero or no motivation experienced (Grouws & Lembke, 1996). Pintrich, (1989) added another component to this model which is the affective factor described as being the student's emotional attachment to the task (Pintrich & DeGroot, 1990). Other research by Iveer, Stipek, and Daniels (1991) has shown the great importance of the student's own capability rating. These researchers have found that the students' level of intrinsic motivation is raised when they feels academically capable of completing assigned tasks. Another study has shown a proven direct correlation between secondary students' perception of individual success in a particular class and their interest level for that class (Stipek, 1993). This research all points to the most important goal for any adult involved in a learning situation. They must make sure that a student is capable of success and experiences success regularly.

Closely connected to the self-efficacy idea is the research on self-esteem. As students put forth effort to achieve desired results, they are in the process of building self-esteem. This inner development is built very carefully and very slowly and is not

easily achieved. The result of this hard won experience is long lasting, enduring, and capable of producing future growth. Self-esteem is not a prerequisite for learning but a byproduct of it. To enhance self-esteem, it is important for an individual to focus on others instead of always on themselves. To bring students out of this internal focus, it is necessary to teach cooperative learning skills, teach respect for authority, and teach social responsibility. Self-esteem will continue to develop as students learn to care about the feelings and rights of others (McMillan, Singh, & Simonetta, 1995). Since this theme of external focus is so important, the answer in the classroom is cooperative learning. Research by Workman and Reardon (1992) compared and contrasted the effects of cooperative learning and traditional learning. The students in the traditional setting were found to have a higher incidence of not knowing their classmates while the cooperative learning class tended to know and care more about each other. The prevalent thinking in the traditional group was every individual needed to take care of himself and they were convinced that someone was going to fail. The cooperative group on the other side of the continuum were willing to help and support each other. The academic result was that both groups had similar class means, but the cooperative group tended to gravitate toward the mean while the traditional group showed a greater diversity of scores (Meyer, 1992).

A student with high self-esteem will focus on achievement and the task to be accomplished which is referred to as task involvement. This direction will lead to greater gain in achievement than ego involvement, which is a focus on self and what the self has to gain by participating in the activity (Spaulding, 1992). The ego-involved students are constantly comparing their performance to others while the task involved

students are comparing their performance with their previous experiences. The latter student will achieve a greater intrinsic motivation.

Johnson (1986) stated three ideas he felt necessary to build self-esteem. First, it is important to focus on students' strengths and to accent the positive. This idea is closely followed by the concept of avoiding the reinforcement of negative thinking for the student or the adult in the classroom. The last strategy encourages the teacher to set high standards for performance but not to expect perfectionism (Krupp, 1992). In summary, self-esteem will flourish when students focus outside of themselves and in turn receive positive responses from this experience (McMillan, Singh, & Simonetta, 1995).

The study of self-efficacy and self-esteem coordinates with the information available on self-regulation. Self-regulated learners will plan and organize their study approach, devise methods to learn easily and remember instructional materials. They will also resist distractions, be motivated to complete tasks and to meet deadlines, work in suitable study environments, and will actively participate in class (Zimmerman, Bandura, & Martinez-Pons, 1992). Research has shown that self-regulation is the best predictor of success in academic pursuits. The strategies mentioned that were valuable in increasing self-regulation are goal setting, planning, persistence, increased effort, and the use of learning strategies (Pintrich & DeGroot, 1990).

The previous mentioned strategy of goal setting will be looked into with further depth. Research has pointed to the valuable practice of goal setting to increase academic achievement and raise internal motivation (Zimmerman, Bandura, & Martinez-Pons, 1992). Bandura and Simon, (1977) have discovered the importance of

proximal goals. These goals that are in fairly easy reach lead to increased performance and a higher level of intrinsic motivation. As students quickly accomplish a goal, they experience a feeling of success and self-efficacy. The result is a desire to continue the pursuit of learning (Schunk, 1984). Johnson (1986) provides guidelines for successful goal setting. His ideas include the following: construct short term goals, create goals that are internally motivated, devise goals with an appropriate level of difficulty, ensure an optimal climate for sharing goals, include a personal control factor in each goal, concentrate on one goal at a time, and state a measurability factor to ensure successfully completing the goal. Individuals who have disciplined themselves in successful goal setting strategies will increase the productivity they experience in life (Krupp, 1992).

The last "self" concept to be discussed is self-reflection. "Students need to self-reflect regularly so that they can become adept at monitoring, assessing, and improving their own performances and their own thinking" (Burke, 1994 p.96). Students' ability to reflect on goals and thought processes will enable them to apply their learning to real-life applications (Burke, 1994). The process of learning unites the two dimensions of reflection and experience. The learners adept at self-reflecting will be able to use this skill to an advantage in their life as well as share these insights with others (Garrison, 1992). The self-reflective learner will exhibit good academic behavior, attitudes, and habits (Ridley). An effective tool in fostering self-reflection is journal writing. Journals allow a student to reflect on the past, contemplate the present, and dream about the future. Journals aid students in revisiting material previously presented, help them to write down questions on material they might have found confusing, and encourage

them to share their feelings on the subject introspectively or with the teacher (Fusco & Fountain, 1992).

The consistent theme present is the need for individuals to take responsibility for their attitudes, beliefs, and behaviors. Students must assume the responsibility for their learning. The idea of "learning to learn" is presented as an individual taking assumption of responsibility through self-reflection and sharing control of this learning with others (Garrison, 1992). The learning process is determined to be an individual responsibility, but the acquisition of knowledge is found by interacting with external stimuli using direct experience and critical dialogue. Therefore, it is the responsibility of each student to understand each learning experience by coordinating new ideas with previous learned material and experiences (Garrison, 1992).

Along with responsibility, motivation will be increased by individuals willing to take ownership of their learning. Research has discovered methods valuable in encouraging students to take ownership and become involved in their learning process. The first idea involves an assignment menu where students may choose the type of assignment they want to use to perform the given task. Varying the assignments is an interesting concept with the length of the assignment determined by the students' quickness in comprehending the material. To use this procedure, it is important that the critical problems be placed first in the assignment and then students who demonstrate comprehension may omit the remainder of the assignment. Other ideas include short term goal setting, self-scoring, and self-correcting (Fulk & Montgomery-Grymes, 1994). As students begin to take responsibility for their own work, they will

learn how to learn as well as what to learn. In the long run, less teaching will yield more learning (National Academy Press, 1989).

John Egsgard, President of the National Council of the Teachers of Mathematics (NCTM) in 1976, defined a good math teacher as "one who uses his knowledge of math as well as his love and respect for his pupils to lead them to an enjoyment of the study of mathematics" (Datta 1993). Many new mathematics teachers try to live up to this definition. All teachers who are concerned about their students' academic motivation would be well advised to take the time to reflect on how their style of relating to students helps to shape their students' motivation level in the classroom (Spaulding, 1992). Research has shown that teachers do influence the motivation level of their students (Newby, 1991, Redick, 1991). Ames and Ames (1984), for example, suggest that the teacher goals and values set forth in the classroom strongly impact task motivation (Newby, 1991). Math teachers must build positive relationships with students by showing interest and concern for them. Teacher-student relationships characterized by mutual respect and trust seem to be the ones that are most likely to nurture academic achievement (Spaulding, 1992).

Project Objective Statement

As a result of the use of strategies to increase motivation during the period of September through December of 1997, the targeted mathematics students will show an increase in self-efficacy, in class achievement, and in a willingness to learn math as measured by teacher checklist, student journals, teacher anecdotal records, and student surveys. In order to accomplish these objectives, the following processes are necessary:

1. Teacher materials and actions that foster motivation will be developed.
2. A series of cooperative learning activities that foster motivation and include multiple intelligence strategies will be developed.
3. Within the teacher's lesson plans, time will be scheduled for writing in mathematics.

Since Researcher A and C targeted Geometry 1 classes and Researcher B targeted a Trigonometry class, two separate action plans are included as follows:

Action Plan for Geometry 1

Week 1: Topic: Language of geometry

A. Students complete the survey (day 1)

B. Students are placed with a partner selected by teacher to apply coordinate geometry skills to a map activity locating specific cities

C. Students make a journal entry. Stem: I had a good experience in math when _____.

D. Teacher journal

Week 2: Topic: Segment measurement and relationships

A. Teacher completes checklist (daily)

B. Individual activity:

1. Find the center of a piece of paper without measuring or using a pen or pencil
2. Write a definition of a midpoint in your own words

C. Students make a journal entry. Stem: I had an uncomfortable experience in math when _____.

D. Teacher journal

Week 3: Topic: Rays and angles

A. Review activity in preparation for a test

B. Students will do constructions using a compass and straightedge

C. Students will model rays and angles with their bodies

D. Pair-Share activity: Drawing and measuring angles

E. Students make a journal entry. Stem: What idea or concept was made clearer by the review? Explain.

F. Teacher journal and checklist

Week 4: Topic: Angles

A. Task group formed by teacher to play portmanteau game

B. Students will do constructions using a compass and straightedge

C. Students make a journal entry. Stem: Write three statements about angles using the terminology learned this week.

D. Teacher journal and checklist

Week 5: Topic: Review

A. Real life application: using a carpenter's T-square to show students how easy it is to use

B. Review activity in pairs: Students will review vocabulary in pairs through a back to back drawing activity

C. Journal entry: Test reflection

D. Teacher journal and checklist

Week 6: Topic: Deductive reasoning

A. Task group to complete an activity on conditional sentences

B. Journal entry: explain the difference between the two laws of deductive reasoning

C. Teacher journal and checklist

Week 7: Topic: Two column proofs with segments

A. Pair share activity with proofs

B. Journal entry: Students will write a list of five essential parts of a proof.

C. Teacher journal and checklist

Week 8: Topic: Two column proofs with angles

A. Pair activity: "cut up" proof activity

B. Pairs brainstorming different ways to prove angles congruent (without notes)

C. Pictionary game for review of theorems and vocabulary

D. Journal entry: test reflection

E. Teacher journal and checklist

Week 9: Topic: Parallel lines

A. Individual activity: Draw two parallel lines and a transversal. Then use a protractor to measure all eight angles. Write conjectures about the angle relationships.

B. Task group activity: discover a letter pattern for each pair of special angles

C. Journal entry: Stem: If I were teaching this math class, the one thing I would change would be _____.

D. Teacher journal and checklist

Week 10: Topic: Parallel lines and slopes

A. Visual demonstration of distance between a line and a point

B. Individual activity: draw a triangle with labeled vertices and determine the shortest distance from the vertex to the opposite side

C. Journal entry: If math were music, what kind of music would it be? Explain.

D. Teacher journal and checklist

Week 11: Topic: Parallel lines

A. Individual activity: Mobius strip

B. Optical illusion enrichment in pairs

C. Journal entry: test reflection

D. Teacher journal and checklist

Week 12: Topic: Triangles

A. Task group activity: Research triangle poster (due before Thanksgiving)

B. Task group activity: Graphic organizer of triangle classifications

C. Pair activity: Exterior angle of triangle equal the sum of the opposite interior angles

D. Journal entry: List all the words or phrases you would use to describe geometry to a friend.

E. Teacher journal and checklist

Week 13: Topic: Triangles

A. Pair-share activity: Discover SSS, SAS, and ASA triangle theorems

B. Task group activity: Proof puzzles

C. Pair-share activity: Discover SSA is not a theorem

D. Journal entry: Name as many real-life examples of triangles as you can

E. Teacher journal and checklist

Week 14: Topic: Isosceles triangles

A. Individual activity: Design a stained glass window using specific types of triangles

B. Journal entry: Choose one of our recent activities and explain why you did or did not like it

C. Teacher journal and checklist

Week 15: Topic: Special segments in triangles

A. Individual project: Geometry collage (due before Christmas)

B. Musical/Rhythmic activity: to learn the definitions of medians and altitudes of triangles

C. Journal entry: Test reflection

D. Teacher journal and checklist

Week 16: Topic: Right triangles and indirect proof

A. Pair-share activity: discover theorems about inequalities for sides and angles of triangles

B. Individual activity: Have students write the right triangle theorems in if-then form (with-out notes) and draw a labeled diagram illustrating those theorems. Lastly write the given and the prove statements if one were to prove the theorems.

C. Journal entry: describe the steps necessary to write an indirect proof

D. Teacher journal and checklist

Week 17: A. Individual activity: use manipulatives to discover triangle inequality theorem

B. Task group activity: use logic puzzles

C. Journal entry: What did you enjoy most about the collage project?

D. Musical/rhythmic review activity

E. Teacher journal and checklist

Action Plan for Trigonometry

Week 1: Topic: Pythagorean Theorem

A. Students complete the survey (day 1)

B. Students are placed in groups of three or four to explore the Pythagorean Theorem

C. Students make a journal entry. Stem: I had a good experience in math when _____.

D. Teacher journal

Week 2: Topic: Special right triangles and families of right triangles

B. Group multiple intelligence activity. Learn trig functions with SOHCAHTOA song

C. Pair-Share activity: Create Pythagorean triple problems for partner solve

D. Journal entry: Write a letter to an absent or fictitious classmate explaining how to find the measures of both legs of a 30-60 right triangle given the measure of its hypotenuse. Do the same for a 45-45 right triangle given its hypotenuse.

E. Teacher journal

Week 3: Topic: Solving right triangles using trigonometry

A. Journal entry: Use stem I had an uncomfortable experience in math when ___.

B. Teacher journal and checklist

Week 4: Topic: Applications of trig functions

A. Task groups formed by teacher to assemble hypsometers and to use trig to gather indirect measurements outdoors

B. Pair-Share activity: Given a diagram, write a word problem that uses the angle of elevation or the angle of depression. Exchange problems and solve each others.

C. Journal entry: What do you know about surveying? Discuss the need for more than a ruler or protractor to find the distance across rivers and valleys.

D. Review activity in preparation for a test: Jeopardy

E. Teacher journal and checklist

Week 5: Topic: Degree and radian measures, unit circle

A. Review activity group game: I Have, Who Has

B. Pair-share activity: Each partner creates five sets of angles some which are coterminal and some which are not. Exchange papers and let partner figure out which ones are coterminal.

C. Task group activity: Fill in the trig chart

D. Journal entry: Test reflection

E. Teacher journal and checklist

Week 6: Topic: Trig functions and their inverses

A. Cooperative jigsaw: Discover the relationship between the trig functions of complementary and supplementary angles

B. Pair-share activity with journal entry: Respond to the following questions:

1. In the table of trig ratios, what is happening to sin A as $\angle A$ increases?
2. As $\angle A$ increases, what number is sin A approaching?

3. Write a generalization based on your answers

4. Write a generalization between the cos A and the measure of $\angle A$.

C. Teacher journal and checklist

Week 7: Topic: Law of sines

A. Task group activity: Discover that solving the area of a triangle by the law of sines will yield the same results as measuring the base and height and using the formula, $A = \frac{1}{2}bh$

B. Journal entry: Recall what information about a triangle you need in order to solve it. Write about situations in which the law of sines could not be used.

C. Teacher journal and checklist

Week 8: Topic: Law of cosines

A. Task group activity: Design the perfect golf club

B. Pair-share activity: Discuss with your partner and write down ideas where you would use the law of sines, the law of cosines, and the trig ratios of sine, cosine, and tangent to solve problems.

C. Journal entry: Test reflection

D. Teacher journal and checklist

Week 9: Topic: Sine and cosine graphs

A. Task group activity: Graphing sine and cosine curves

B. Journal entry: Stem: If I were teaching this math class, the one thing I would change would be _____.

C. Teacher journal and checklist

Week 10: Topic: Graphing the trig functions

A. Pair-share activity: Using graphing calculators explore the effects of translations, amplitude, and period on trig functions

B. Individual activity: Assign second nine weeks project to be due before Christmas. Choose one of the following options:

1. Create an original drawing using trig curves. Each graph must be labeled with a correct equation
2. Research and write about an occupation that uses the study of trigonometry

C. Journal entry: At the start of this new nine weeks, think about and write down ideas on what you would like to change about your performance in this class.

D. Teacher journal and checklist

Week 11: Topic: Trig identities

A. Group activity: Match game - Match the graph to the correct equation. Also match one side of a trig identity to its other side.

B. Journal entry: If math were music, what kind of music would it be? Explain.

C. Teacher journal and checklist

Week 12: Topic: Trig identities

A. Task group activity: Each group rewrite trig identities making some true and some false. Then give to another group to find the correct identities.

B. Pair activity: Analyze excerpt from Russian geometry book to see what identity is being proven.

C. Journal entry: List all the words or phrases you would use to describe trigonometry to a friend.

Week 13: Topic: Trig identities

A. Task group activity: Identity puzzles

B. Journal entry: Explain how solving a trig identity is like building a model car.

C. Teacher journal and checklist

Week 14: Topic: Sum and difference of angles formulas

A. Task group activity: Review game for test

B. Journal entry: Choose one of our recent activities and explain why you did or did not like it.

C. Teacher journal and checklist

Week 15: Topic: Double-angle and half-angle formulas

A. Pair-share activity: One student uses the sum formula to find cos 60. The partner uses the difference formula to find the cos 60. Compare results.

B. Journal entry: Test reflection

C. Teacher journal and checklist

Week 16: Topic: Solving trig equations

A. Journal entry: Explain why it is necessary to check solutions to equations.

B. Teacher journal and checklist

Week 17: Topic: Converting to polar and rectangular form

A. Task group activity: Trig Pictionary

B. Journal entry: What did you enjoy most about this class? What would you like to change?

C. Teacher journal and checklist

Methods of Assessment

In order to assess the effects of the intervention, student surveys were given in the targeted classes at the beginning and the end of the intervention period. This questionnaire was developed to assess student motivation and attitude toward mathematics. In addition, a teacher weekly recorded checklist was used to monitor the progress or decline of the targeted observable behaviors. Also teacher anecdotal records were completed on a weekly basis to record positive and negative aspects of

the ongoing project. Finally, student journals were administered throughout the intervention to discover student thoughts and ideas.

CHAPTER 4

PROJECT RESULTS

Historical Description of the Intervention

The objective of this project was to increase student motivation in mathematics by creating a caring and positive classroom. This environment was established by displaying student products and by increasing student-teacher communication through journaling. The targeted mathematics students were expected to show an increase in self-efficacy, in class achievement, and in a willingness to learn mathematics. The implementation of cooperative learning, writing in mathematics, and use of multiple intelligences was selected to effect the desired changes. At the beginning of the intervention, students were given a survey (Appendix A) to determine a baseline of motivation levels. The same survey was administered at the end of the intervention to determine its effectiveness.

Cooperative learning was used to establish a caring and positive classroom. Pair-share, task-group, and whole-group activities were planned approximately once a week. These activities were used to practice skills pertaining to the lesson, to review concepts, to discover mathematical connections and patterns and to create group projects.

The students were introduced to writing in mathematics for the first time. Each week the students were given the opportunity to reflect their thoughts in a journal entry. The journals (Appendices O, P, and Q) consisted of entries made with stem statements, test reflections, or student feelings and opinions. Alternate writing assignments designed to assess comprehension were also given as journal entries. Student journaling allowed each pupil to grow intrapersonally. Some examples of stem statements used were as follows:

- I had a good experience in math when _____
- If I were teaching this math class, the one thing I would change would be ____
- If math were music, what kind of music would it be?
- List all the words or phrases you would use to describe trigonometry-geometry to a friend.
- Choose one of our recent activities and explain why you did or did not like it.
- Write a letter to an absent or fictitious classmate explaining how to find the measures of both legs of a 30-60 right triangle given the measure of its hypotenuse.

Multiple intelligences were integrated into the daily lessons to increase student engagement and learning. All seven intelligences were employed at some time during the intervention. The mathematicalorlogical intelligence lent itself well to graphic organizers. A chart was used to enable students to transfer previously learned algebraic properties to geometric concepts (Appendix C). In order to develop students' logical thinking, a table was utilized to organize facts (Appendix D). This table incorporated an elimination procedure to discover the solution to logic word problems.

The geometry students found that learning the Law of Detachment and the Law of Syllogism was easier when using the graphic organizers found in Appendix E.

Projects and activities were employed during this intervention to develop the bodily/kinesthetic intelligence. The game, Pictionary, was used to review vocabulary for the nine weeks test. The vocabulary list needed for this game is found in Appendix F. The Portmanteau activity reinforced vocabulary words while strengthening the verbal/linguistic, interpersonal, and bodily/kinesthetic intelligences (Appendix R). Geometric constructions (Appendix G) were practiced in cooperative pairs, applying interpersonal and bodily/kinesthetic intelligences. The cooperative pairs in this activity helped to facilitate learning. In the study of trigonometry, students found outdoor measurements by using hypsometers (Appendix H). A hypsometer was constructed with a protractor, straw, string, and a paper clip. This device represented a crude surveying tool for measuring angles. Students enjoyed this outdoor experience while developing their bodily/kinesthetic and interpersonal intelligences. Another trigonometry project addressing the same two intelligences, was the sine and cosine graph project (Appendix I). Pairs of students, through detailed instructions, discovered the shape of the sine and cosine curves.

To further develop their knowledge of trigonometric graphs and enhance their visual/spatial and interpersonal intelligences, students were then asked to individually create a design using a minimum of eight equations. As an alternative to this project, the students were given the option of writing a paper about the use of mathematics in a career. The second option appealed to the verbal/linguistic student (Appendix J).

A trigonometric activity addressing the musical/rhythmic intelligence was singing the mnemonic SOHCAHTOA to the tune of "Oklahoma" (Appendix K). Christmas carols adapted to a mathematics theme were also sung in the geometry classes before Christmas (Appendix L). Students appreciated the musical diversions to the classroom routine.

A geometry collage project was assigned to develop interpersonal, verbal/linguistic, and bodily/kinesthetic intelligences. Appendix M gave detailed directions and a rubric for the collage project enjoyed by many students. Another geometry group activity was designed to help students learn the characteristics of a given triangle (Appendix N). This interpersonal activity was also bodily/kinesthetic.

The dominate intelligence interwoven throughout all the activities and projects is mathematical/logical. Various puzzles fortified this intelligence. Proof puzzles enabled students to comprehend the sequencing of the pieces in a proof (Appendix S). To add classroom variety and enjoyment, puzzles were interspersed throughout the intervention (Appendices T and U).

In order to document the progress of the action plan, the researchers kept weekly journals. This log provided insight and reflections as to the positive, negative, and interesting aspects of the actions taken each week. Also, each teacher collected baseline data by completing a checklist of eight observable behaviors on eight or nine targeted students (Appendix B). This checklist was recorded daily for one week early in the semester. The teachers continued to record this information on a weekly basis to monitor student progress.

Presentation and Analysis of Results

In order to assess the effects of cooperative learning and multiple intelligences on student motivation in mathematics, the student survey (Appendix A) was re-administered at the end of the intervention. The data collected represents the number of responses to the questions pertaining to each behavior. The results were tabulated from the three researchers' entire targeted classes. Due to the slight change in the number of students surveyed, the raw data were changed to percentages. These results were compared to the pre-intervention responses as presented in TABLE 4.1.

OBSERVABLE MOTIVATIONAL BEHAVIORS

	Most of time		Sometimes		Never	
	Pre	Post	Pre	Post	Pre	Post
Has materials	92%	93%	8%	7%	0%	0%
Begins promptly	60%	67%	39%	31%	1%	1%
Participates in class	32%	36%	67%	61%	1%	2%
Uses time wisely	55%	53%	45%	44%	0%	3%
Completes make-up work	79%	82%	21%	17%	0%	1%
Seeks help	52%	39%	43%	58%	5%	3%
Completes assignments	79%	71%	21%	25%	0%	4%

Table 4.1

It should be noted that the categories "most of the time" and "once in a while" were combined under the single heading of "sometimes". Two questions, numbers 3 and 21, in the student survey addressed student participation. Therefore, the number of the responses was averaged. Similarly, questions 15 and 23 were combined to survey the students' willingness to ask for help. Averaging of results produced some decimal data.

As indicated in TABLE 4.1, the targeted classes of juniors and seniors at the beginning of the survey had a realistic view of themselves as students with a touch of

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optimism present at the beginning of the school year. The behaviors of "has materials" and "completes make-up work" started high and showed slight increases in the "most of the time" column. In addition, categories showing substantial increases in the first two columns were "participates in class" and "begins promptly". Given these increases, the researchers theorize that students' perception of their motivation has improved. This improvement is corroborated by teacher and student journal entries such as "The thing I enjoyed most about this class is that I never dreaded coming to class. I like the way the class was taught and that everything wasn't so uptight and strict." In addition, teacher journal entries noted that the multiple intelligences and cooperative learning activities increase the amount of student engagement and enthusiasm toward learning. The researcher illustrates this idea in the following journal entry:

> The class seems to be more comfortable at working cooperatively to solve the complicated Trig identities. They help each other, explore together, and conquer tasks that would be difficult on their own. The activities from this project make this class much more enjoyable and more challenging for the students.

As shown in TABLE 4.1, the behavior of "completes assignments" decreases in the column of "most of the time", it increases in the "sometimes" column. Likewise, "seeks help" follows the same pattern but shows a more dramatic increase in the "sometimes" column. Student journal statements such as "I did better on the test because I came in for help" and "You have to keep on top of it or you'll never make it" suggest that students have internalized the need to consistently do homework and to ask questions when confused. Teachers recorded in their journals that students asking questions

reduced their frustration level. When doing homework on a regular basis, self-confidence increased which produced a by-product of higher motivation.

Unfortunately, the behavior, "uses time wisely" decreased slightly in each column. The researchers believe that one reason this reduction occurred was because of a student's tendency to procrastinate. Another contributing factor to this decline may have been student laziness.

The intervention as noted by the students' responses in the survey appears to have an overall positive effect on the targeted classes. The student and teacher journals also reflected greater enjoyment of the class which ultimately increased the motivational level of everyone involved.

TABLE 4.2 is a comparison between the teacher checklist (Appendix B) completed early in the intervention and the ongoing checklist. Researcher A and B compiled information on eight targeted students. Researcher C collected data based on nine targeted students. In order to study the changes made in student behavior and attitudes, the researchers completed a weekly record of eight targeted behaviors.

TEACHER CHECKLIST OF OBSERVABLE BEHAVIORS

	Researcher A		Researcher B		Researcher C		Average	
	Pre	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*
Has materials	93.5%	86.7%	83.5%	87.5%	100%	99.0%	92.3%	91.0%
Begins promptly	100%	79.5%	95.0%	87.5%	73.5%	93.5%	89.5%	86.8%
Completes assignments	93.0%	50.5%	83.0%	77.5%	76.5%	77.0%	84.2%	68.3%
Uses time wisely	77.0%	55.0%	89.5%	87.5%	93.0%	91.5%	86.5%	78.0%
Participates in class	58.5%	56.5%	81.5%	54.5%	68.5%	54.5%	69.5%	55.2%
Tries ungraded work	91.5%	54.5%	97.0%	87.5%	71.0%	92.5%	86.5%	78.2%
Seeks help	12.5%	17.5%	31.5%	55.5%	30.0%	56.5%	24.7%	43.2%
Completes make-up work	78.5%	51.5%	100%	69.0%	50.0%	56.5%	76.2%	59.0%

Table 4.2

According to TABLE 4.2,the percentage of students willing to seek help almost doubled during the intervention period. The teachers theorize that the techniques used during this intervention broke down the barriers in the classroom. Additionally, student journals indicated that they were comfortable asking questions of each other as well as of the teacher.

However, the rest of the results showed decreases. The three categories of "completes assignments", "participates in class", and "completes make-up work" have significantly decreased from pre-intervention to post-intervention. Even though the conclusions made from the student survey showed increases in these behaviors, the teachers' perception showed a marked difference. This discrepancy can be contributed to the fact that the teachers recorded information on only eight or nine targeted students as opposed to an entire class. Even with a randomly chosen sample of students, Researcher A had four failures out of the targeted eight. These four students skewed the data. Researcher A believed that late night employment contributed to lack of time and lack of energy needed to succeed in the course. Although the students enjoyed the in-class activities, all researchers noticed some signs of laziness present among students when they were asked to work individually. As the semester progressed, the material in each of the courses became more difficult which frustrated some students to the point where they did not do homework. They participated in the in-class activities but too often failed to complete difficult assignments on their own. Since all targeted students are in middle track mathematics classes, the researchers hypothesized that the intrinsic motivation needed for a student to rise to a challenge has been missing for quite some time. As noted in Chapter 2 of our research,

motivation cannot be measured because it involves a person's past, present, and future behavior (Hall, 1982).

Conclusions and Recommendations

The researchers believe that the intervention did make a difference for themselves as well as their students but felt that they had few effective tools to measure the success. The results of the student surveys completed early in the intervention indicated that the students were optimistic about their motivational behaviors. Typically students are ready to start the school year with enthusiasm and hopefulness of a good beginning. Adolescents' feelings and attitudes can change daily which affects the validity of this survey as a measuring tool. The student survey was again administered at the end of the semester during final exam week, a time when students have many concerns on their minds. As the researchers observed the students polishing off this final survey hastily, they questioned the validity of the survey as a scientific tool. Due to the aforementioned facts, the researchers questioned the reliability of this tool for measuring motivation.

The teacher checklist of observable behaviors was another measuring device used by the researchers. This checklist may have been more useful had we been able to study the entire targeted class. Instead, eight or nine students were studied by each researcher. This small number of students simply was not large enough to result in data giving valid conclusions. Also, the researchers did not feel they had adequate time to make a daily checklist on just eightornine students. With the multitude of tasks that teachers are required to perform daily, the additional duty of recording student behavior was formidable. Due to the stress that this duty put upon the researchers,

the accuracy of the research from the teacher checklist could be questionable. An observer checking behaviors for the researchers while they were teaching would have made a tremendous difference. Consequently, the researchers feel their data may not be entirely representative of the targeted students' behaviors.

The researchers felt that their most significant measuring tool of motivational behaviors was studentorteacher journals. When students wrote in their journals, they were encouraged to reflect on their feelings toward the activities and the overall class environment. Upon writing in journals, students to clarify mathematical content in their own language. Stem statements were given to students weekly to channel individual thought. The following are examples of stem statements and student responses the researchers thought illustrated success of their intervention:

If math were music, what kind of math would it be?

- I think math would be jazz because it has ups and downs of difficulty and yet it always goes together.
- Math would be a tuba it if were a musical instrument. The reason for this is because the tuba in the band is the base and the rest of the band balances it This compares to math because math is the basis of what a person needs to survive in society. So math would be comparable to a tuba.
- Math would be classic rock, because math is the foundation of many things. You use it every day for many things like architecture or balancing your checkbook. Like classic rock, is the foundation of music today, math is the

foundation of knowledge. It's hard to get by in life without it. You see it everywhere even though you may not realize it.

If I were teaching this math class, the one thing I would change would be _____

- I wouldn't change anything because I like this class. I like how you take time during class making sure everyone knows how to do a certain problem. You also let us work in groups which also helps me.

Choose one of our recent activities and explain why you did or did not like it.

- I liked doing the collage project. I liked putting pictures on it and finding things that helped me with learning the meaning of geometric terms. It made me understand them better. It also let me be artistic, which makes me happy.

- I like getting into groups to do our triangle. It was fun and also helpful. I also like getting into group and doing proofs. I didn't like doing the proof but it did help me understand it more. I like doing the collage, too. It was really helpful to talk to other students that have to do it and get good ideas off each other.

- I liked doing the poster board project. It was fun and I liked that we could pick our own way of doing it.

- I like when we play games on the board because it's different and for the most part, a fun way of learning, and when it's fun you usually remember it better.

List all the words or phrases you would use to describe geometry to a friend.

- sometimes confusing. understandable (sometimes), occasionally easy. lots of shapes, lots of angles (which is easy), triangles, rectangles, too many proofs
- fun, challenging, stressful. confusing sometimes, sometimes easy
- not different, more fun than algebra, easier than algebra, fun, easier to think out, things you deal with daily, easy to see, should take it, interesting
- real-life like shapes and examples, lots of angles, creative thinking, orderly thinking, kind of everlasting
- fun, but hard sometimes, use a lot of thinking
- is needed in life, shows relationship of different shapes, is used to build
- sometimes hard, sometimes easy, fun, not too much homework, a lot of terms, some drawing, angles, triangles

Write a generalization between the cos A and the measure of ∠A.

- It does the exact opposite of sin A. As the angle gets larger, the sin A decreases to 0.00.

Write a letter to an absent or fictitious classmate explaining how to find the measures of both legs of a 30-60 right triangle given the measure of its hypotenuse.

- I am writing in regards to your request for information about finding the measure of the legs of a 30-60 right triangle. The hypotenuse = 2x so to find the short leg you divide by 2, then you have x. To find the long leg you

multiply x by $\sqrt{3}$. Then you have your long leg. There you have it. Pretty basic stuff.

Choose a problem you got wrong on your test and explain why you missed it.

- I forgot to put the hypotenuse in the equation. Cosine means $\frac{\text{adjacent leg}}{\text{hypotenuse}}$ and I just put the adjacent leg for my answer.

In their journals, the teachers indicated a feeling of success during this intervention. The added variety of activities significantly increased teacher enjoyment which in turn enhanced student motivation. The following are examples of teacher journal entries noting the progress and success of the intervention.

- I feel that the project is going well at this time and am enjoying the activities along with my students. The negative aspect is that I feel like I'm cheating my other classes. I'm giving them what I have in the past but it pales in comparison with my project class.
- All students were working and all of the graphs were correct - unbelievable☺. The depth of understanding was amazing. They came up with as a group at the conclusion of the project ideas that I'm certain that they never would have considered otherwise.
- I am getting toward the end of the time allotted for the project, and I am noticing more student involvement and participation. Today a shy, quiet student volunteered to put up a trig identity and explained it to the class. I was pleasantly surprised.

- Overall, I felt as if this action plan and project made my class a more interesting place to be for the students as well as myself! I do believe that this enjoyment did have a direct positive impact on motivation. As a result, my intention is to implement more ideas similar to these into my other classes!
- Pictionary went well. It was a good change of pace.
- I love the journal responses (If math were music, ...). Some of the entries were very creative and well stated.
- I was surprised how many students actually referred to the "Properties of Equality" graphic organizer while doing their homework during study period.

The benefits of the intervention cannot be fully appreciated by a mere examination of the documented data. A feeling exists in the researchers' classrooms that can only be understood when observed first hand. The hard data does not show the depth and extent of the peer interactions and teacher-student relationship.

We, the researchers, have several recommendations to share with future researchers. The importance of choosing a few good surveys or other tools for measuring progress cannot be overemphasized. A tool to measure the effectiveness of the lessons could have been employed if the researchers had known how to develop such an instrument. Future researchers should consider what their measuring devices will ultimately accomplish before implementation. This first step will make so much difference to the analysis needed in Chapter 4. Also we recommend that the researchers contemplate the time needed for the use of their measuring devices. The devices will be of no value if the necessary time is not given for implementation. We

wished we had kept more data on entire classes. Correlations needed to be made between all the measuring devices. Any decisions made about scoring techniques should be transcribed. Put everything in writing. We wished that more time had been spent in preparing our measuring tools.

It is the opinion of the researchers that cooperative learning, MI activities, and student journaling did enhance the students' motivation for learning mathematics despite their difficulties with the teacher checklist as a measuring tool. The intervention created a relaxed atmosphere allowing the students to be more comfortable in asking for help when confused. During this period of research, student participation and engagement increased due to the added variety in the class routine. These strategies also made the researchers' job more enjoyable, and the enthusiasm spread to other colleagues. Project and activity ideas were shared with fellow math teachers. The researchers have agreed that they will continue to use these strategies in all future classes.

REFERENCES

Adler, J. (special issue). Creating Problems. Newsweek. 16-22.

Alper, L., Fendel, D., Fraser S., & Resek D. (1996, May). Problem-Based Mathematics – Not just for the College-Bound. Educational Leadership. 18-21.

Anderson, J., Burlison, S., & Nunnery, N. (1994). Market report. Peoria, Illinois: Peoria Journal Star.

Bacon, C.S. (1993, Spring). Student responsibility for learning. Adolescence, 28 (109), 199-212.

Blackburn, M. (1995, October 9). How to interest and motivate our students. Elon College.

Bracey, G.W. (1995, May). Research status and expectancies. Phi Delta Kappan. 727-728.

Buerk, D. (1990). Writing in Mathematics: A Vehicle for Development and Empowerment. In Andrew Sterrett (Eds.). Using Writing to Teach Mathematics. (pp. 78-84). Mathematical Association of America.

Buerk, D. (1994). Broadening students' conceptions of mathematics: theory into action. In Buerk, D. (Ed) Empowering students by promoting active learning in mathematics. (pp. 45-48). Reston, VA: The National Council of Teachers of Mathematics.

Burke, K. (1994). Metacognitive reflection. How to Assess Authentic Learning (pp. 95-104). Arlington Heights, IL: IRI/Skylight Publishing, Inc.

Burrill, G. (1997, February). Teaching, Group Work, and the Relation between them. NCTM News Bulletin, 3.

Burrill, G. (1997, April). Show Me the Math. NCTM News Bulletin, 3.

Carlin, M., Ciaccio, L., Sanders, J., & Kress, M. (1997, May). Improving high school students' performance via discovery learning, collaboration and technology. T.H.E. Journal, 24 (10), 62-64.

Center for Governmental Studies, Northern Illinois University (1990). The 1990 school data book. Washington, D.C.: U.S. Government Printing Office.

Collopy, R.B., & Green, T. (1995, September) Using motivational theory with at risk children. 37-40.

Corno, L. (1992). Encouraging students to take responsibility for learning and performance. Elementary School Journal, 93 (1), 16-81.

Covington, M. (1991, Fall). Putting self back in the process: A discussant's perspective. Journal of Experimental Education, 60 (1), 82-88.

Datta, D. (1993). Math Education at its best: The Potsdam Model. MA: The center for teaching/learning of mathematics, 8-57, 146-158.

DeMeulemeester, K. (1995). Math Projects. IL: Dale Seymour.

Ehrich, P. (1994). Writing and cognition: implications for mathematics instruction. In Buerk, D. (Ed) Empowering students by promoting active learning in mathematics (pp. 31-36). Reston, VA: The National Council of Teachers of Mathematics.

Elam, S.M., Rose, L.C., & Gallup, A.M. (1993, October). Phi Delta Kappa/Gallop Poll of the attitudes toward the public school. Phi Delta Kappan 139-140.

Ellison, L. (1992, October). Using multiple intelligences to set goals, Educational Leadership, 15 (2), 69-72.

"Everybody Counts". A report to the nation on the future of mathematics education. (1989). Washington, D.C: National Academy Press.

Firestone, W.A. (1989, February). Beyond order and expectations in high schools serving at-risk youth., Educational Leadership, 41-45.

Fulk, B. & Montgomery-Grymes, D. (1994, September). Strategies to improve student motivation. Intervention in School and Clinic, 30 (1), 28-34.

Fusco, E., & Fountain, G. (1992). Reflective teacher, reflective learner. In A.L. Costa, J.A. Bellanca, & R. Fogarty (Eds.), If minds matter: A foreward to the future, Volume I (pp. 239-255). Palatine. IL: IRI/Skylight Publishing, Inc.

Fusco, E., & Fountain, G. (1992). Reflective teacher, reflective learner. In A.L. Costa, J.A. Bellanca, & R. Fogarty (Eds.), If minds matter: A foreward to the future, Volume I (pp. 239-255). Palatine. IL: IRI/Skylight Publishing, Inc.

Gallicchio, B.C., (1993, May). Motivating average students in groups. Education Digest 58 (9), 49-52.

Garrison, D.R. (1992). Critical thinking and self-directed learning in adult education: An analysis of responsibility and control issues. Adult Education Quarterly, 42 (3), 136-148.

Gibson, H. (1994). "Math is like a used car": metaphors reveal attitudes toward mathematics. In Buerk, D. (Ed) Empowering students by promoting active learning in mathematics (pp. 7-12). Reston, VA: The National Council of Teachers of Mathematics.

Gitomer, D. (1994, Fall). Learning by Doing *What*? American Educator, 18 (3), 34-35.

Grouws, D. & Lembke, L. (1996). Influential factors in student motivation to learn mathematics: The teacher and classroom culture. In Carr, M. (Ed.), Motivation in mathematics (pp. 39-62). Cresskill, NJ: Hampton Press, Inc.

Hall, S. (1982). Motivation. In Mitzel, H.E. (Ed). Encyclopedia of Educational Research,: Vol. 3 (5th ed., pp. 1256-1263). New York: Free Press.

Hicks, L. (1997, March). How do academic motivation and peer relationships mix in an adolescent's world? Middle School Journal, 28 (4), 18-22.

Hootstein, E.W. (1994, March/April). Motivating students to learn. The Clearing House, 67, 213-216.

Hunter, Madeline. (1982). Mastery teaching. Thousand Oaks, CA: Corwin Press.

Hwang, Y. (1995, summer). Student Apathy, lack of self-responsibility and false self-esteem are filling American schools. Education, 115 (4), 484-490.

Jordan, S. (1996, November). Multiple Intelligences: Seven Keys to Opening Closed Minds. NASSP Bulletin, 80, (583), 29-35.

Keith, S. (1990). Writing for Educational Objectives in a calculus course. In Andrew Sterrett (Eds.). Using Writing to Teach Mathematics. (pp. 6-10). Mathematical Association of America.

Kenney, E. (1990). A reply to Questions from Mathematics Colleagues on Writing Across the Curriculum. In Andrew Sterrett (Eds.), Using Writing to Teach Mathematics (pp. 18-20). Mathematical Association of America.

Krupp, J. (1992). Self-esteem and the willingness to change. In A.L. Costa, J.A. Bellanca, & R. Fogarty (Eds.), If minds matter: A foreward to the future, Volume I (pp. 163-172). Palatine, IL: IRI/Skylight Publishing, Inc.

MacIver, D.J & Reuman, D.A. (1993/1994, Winter). Giving Their Best. American Educator 17 (4), 24-31.

McMillan, J.H., Singh, J., & Simonetta, L. (1995). Self-oriented self-esteem self-destructs. Educational Horizons, 9-11.

McCombs, B.L., (1991). Unraveling motivation: new perspectives from research and practice. Journal of Experimental Education, 60 (1), 3-13.

Meyer, M. (1992). The power and the promise of cooperative learning. In A. L. Costa, J.A. Bellanca, & R. Fogarty (Eds.), If minds matter: A foreward to the future, Volume II (pp. 221-229). Palatine, Il: IRI/Skylight Publishing, Inc.

Middleton, J. (1995). A study of motivation in the mathematics classroom: A personal constructs approach. Journal for Research in Mathematics Education, 26 (3), 254-279.

Natale, J.A. (1996) Making smart cool. Education Digest, 9-12.

Nelson, K. (1995, July/August). Seven ways of being smart. Instructor, 26-34.

Newby, T. (1991). Classroom Motivation: Strategies of First-Year Teachers. Journal of Educational Psychology, 83 (2), 195-200.

Nichols, J.D. & Miller, R, B. (1994). Cooperative Learning and Student Motivation. Contemporary Educational Psychology, 19, 167-178.

Pekin Area Chamber of Commerce. (1995). Demographics (Brochure). Pekin, Illinois.

Pekin Community High School District 303. (1996). School Report Card. Pekin, Illinois.

Pintrich, P., & DeGroot, E. (1990). Motivation and self-regulated learning components of classroom academic performance. Journal of Educational Psychology, 82 (1), 33-40.

Redick, S. (1991). Motivating Youth at Risk. Home Economics Education Association, 22-32.

Ridley, D.S. (1991, Fall). Reflective self-awareness: a basic motivational process. Journal of Experimental Education, 60, (1), 31-48.

Rimm, S. (1997). An underachievement epidemic. ASCD Educational Leadership, 54 (7).

Schifter, D. (1996, March). A Constructivist Perspective on Teaching and Learning Mathematics. Phi Delta Kappan, 492-499.

Schoen, H.L. & Hallas, D. (1993). Improving the general mathematics experience. In P.S. Wilson (Ed.) Research ideas for the classroom: high school mathematics. New York: Macmillan Publishing Company.

Schunk, D. (1984). Self-efficacy perspective on achievement behavior. Educational Psychologist, 19 (1), 48-58.

Silver, E., Kilpatrick, J., & Schlesinger, B. (1990). Thinking Through Mathematics. NY: College Entrance Examination Board.

Sipka, T. (1990). Writing in Mathematics: A Plethora of Possibilities. In Andrew Sterrett (Eds.). Using Writing to Teach Mathematics. (pp. 11-13). Mathematical Association of America.

Sobel, M.A., & Maletsky, E.M. (1988). Teaching Mathematics. Englewood, CA: Prentice Hall.

Sosniak, L.A., & Ethington, C.A. (1994). When teaching problem solving proceeds successfully in U.S. eighth-grade classrooms. In I. Westbury, C.A. Ethington, L.A. Sosniak, & D. B. Baker (Eds.) In search of more effective mathematics education (p. 46). Norwood, NJ: Ablex Publishing Corporation.

Spaulding, C.L. (1992). Motivation in the classroom. New York: McGraw-Hill, Inc.

Standera, M. (1994). Listening to students through writing. In Buerk, D. (Ed) Empowering students by promoting active learning in mathematics. Reston, VA: The National Council of Teachers of Mathematics, 25-29.

Stevens, L., Van Werkhoven,W., & Castelijns. (1997, May). In the Netherlands, Reclaiming Kids' Motivation. Educational Leadership, (8), 60-62.

Stipek, D. (1993). Motivation to learn (Sec. ed.). Needham Heights, MA: Allyn and Bacon.

Sutton, S. (1997, February). Finding the Glory in the Struggle: Helping Our Students Thrive When Math Gets Tough. NASSP Bulletin, 81, (586), 43-52.

U.S. Department of Commerce (1993). 1992 census of population and housing. Washington, D.C.: U.S. Government Printing Office.

Uttal, D. (1996). Beliefs, motivation, and achievement in mathematics: A cross-national perspective. In Carr, M. (Ed.), Motivation in mathematics (pp. 25-37). Cresskill, NJ: Hampton Press, Inc.

Watson, E. (1996, April). Too many students lack academic motivation. Headway, 8, (4), 1.

Wood, G. (1992). Schools that Work. New York: Dutton.

Zimmerman, B.J., Bandura, A., & Martinez-Pons, M. (1992). Self-motivation for academic attainment: The role of self-efficacy beliefs and personal goal setting. American Educational Research Journal, 29 (3), 663-676.

Zimmerman, B.J., (1994). Dimensions of academic self-regulation: a conceptual framework for education. In Schunk, D. H. & Zimmerman, B. J (Eds.), Self-Regulation of Learning and Performance: Issues and Educational Applications (p.11). Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.

APPENDICES

Appendix A

STUDENT SURVEY

NAME: _____

	Most of the time	Some of the time	Once in a while	Never
1. I have materials related to the day's task (calculator, pencil, book, etc.)				
2. I am ready to start at the beginning of class.				
3. I participate in class discussions.				
4. I usually receive the grade in math that I deserve.				
5. I maintain interest in class work that involve group activities.				
6. I use class time wisely.				
7. I feel that most math lessons are relevant to real-life situations.				
8. I am responsible for missed work and make arrangements for makeup.				
9. My grade motivates my performance in math.				
10. I enjoy the challenge of moving on to new work that is at more difficult level.				
11. I use returned tests and quizzes to learn from my mistakes.				
12. I feel that I will not understand math no matter how hard try.				
13. My attitude about math is affected by my parents' attitudes about math.				
14. I like to do extra credit so that I can get better grades.				
15. I seek clarification on assignments by asking for help.				
16. I feel that I am able to do the assignment.				
17. I complete my assignments.				
18. I solve problems without teacher assistance.				
19. I feel that if I study, then I do well on test/quizzes.				
20. Working after school takes away from my studies.				
21. I participate in class activities				
22. I would rather do assignments that are fairly easy.				
23. I ask the teacher for help when I am stuck on a problem.				
24. Extra-curricular activities motivate me to do better work in class.				
25. I feel that my opinion is valued by my teacher.				
26. I like to do extra credit so that I learn about topics that interest me.				
27. I need to see my grade posted so that I know how well I am doing in the class.				
28. I prefer learning new material from teacher lecture rather than from group activities.				

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Appendix B

TEACHER CHECKLIST

Date: _____

-1 = not usually true; 0 = sometimes true; +1 = usually true

STUDENT	A	B	C	D	E	F	G	H	I	J	TOTAL	AVERAGE
1. Has materials related to the day's tasks												
2. Is ready to start at the beginning of class												
3. Completes assignments												
4. Knows how to use class time wisely												
5. Participates in class discussions/activities												
6. Works hard on ungraded tasks												
7. Asks questions to aid in the understanding of the assignment												
8. Is responsible for make-up work												
TOTAL												
AVERAGE												

83

84

Properties of Equality
LOOK LIKE (EXAMPLES)

	ALGEBRA	SEGMENTS	ANGLES
Reflexive Property			
Symmetric Property			
Transitive Property			
Addition Property			
Subtraction Property			
Multiplication Property			
Division Property			
Substitution Property			
Distributive Property			

Appendix C

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6. FAMILY AT HOME

Each member of the Smith family—father, mother, daughter, son and aunt—is in a different room doing something. One is reading, one is writing a letter, one is watching T.V., one is on the telephone, and one is doing a crossword puzzle. The five rooms in which these activities are taking place are the living room, the dining room, a bedroom, the kitchen, and the den. Where is each family member and what is he or she doing?

1. Someone is reading in the living room.
2. Neither of the men is the person in the dining room or the person on the telephone but one of them is in the bedroom.
3. The person doing the crossword puzzle occasionally calls out for help with a clue to the person in the living room and the aunt.
4. The person in the den is not one of the women and is not writing, nor are the women writing the letter.
5. One of the parents is watching T.V. and one of the children is doing the crossword.
6. The person in the den is not doing a crossword puzzle.

	LIVING	DINING	BEDROOM	KITCHEN	DEN	READING	WRITING	T.V.	PHONE	CROSSWD
FATHER										
MOTHER										
DAUGHTER										
SON										
AUNT										
READING										
WRITING										
T.V.										
PHONE										
CROSSWD										

LAW OF DETACHMENT

If _____ , then _____

_____ is true.

CONCLUSION: _____

LAW OF SYLLOGISM

If _____ , then _____

If _____ , then .....

CONCLUSION:

If _____ , then .....

LAW OF DETACHMENT/LAW OF SYLLOGISM ACTIVITY

1. Pass out 4 x 6 card to each student.

2. Students will copy from the overhead and fill in the blanks for the law of detachment with their own ideas.

3. Turn card over and copy from the overhead and fill in the blanks for the law of syllogism with their own ideas.

4. Partners should pass their cards to each other and discuss the truth value of the conclusions.

5. Students should put their names on the upper right hand corner of the card and pass them forward for 2 points.

6. Class discussion after pair-share.

VOCABULARY REVIEW FOR GEOMETRY 1 SECOND QUARTER EXAM

parallel lines

skew lines

intersecting lines

alternate interior angles

alternate exterior angles

corresponding angles

consecutive interior angles

vertical angles

linear pair of angles

slope formula

slopes of parallel lines

slopes of perpendicular lines

hypotenuse

legs of an isosceles triangle

equilateral triangle

equiangular triangle

scalene triangle

right triangle

obtuse triangle

vertex angle

acute triangle

base angles

legs of a right triangle

base

AAS

SAS

ASA

SSS

HL

HA

LL

LA

isosceles triangle

median

altitude

perpendicular bisector

median

midpoint formula

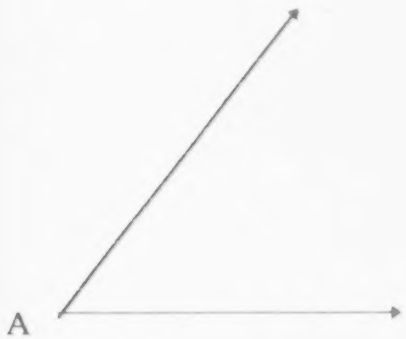
exterior angle of a triangle

distance from a point to a line

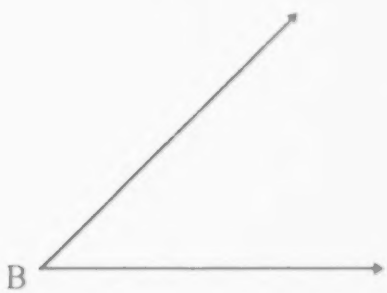
angle bisector

Geometry 1
Review of Constructions

1. Construct an angle congruent to < A.



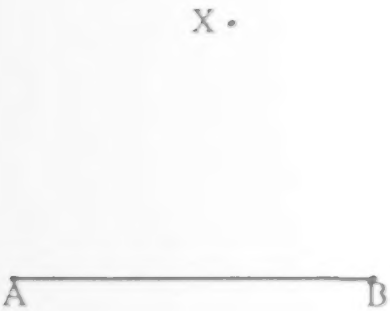
2. Construct the bisector of < B.



Geometry 1
Review of Constructions

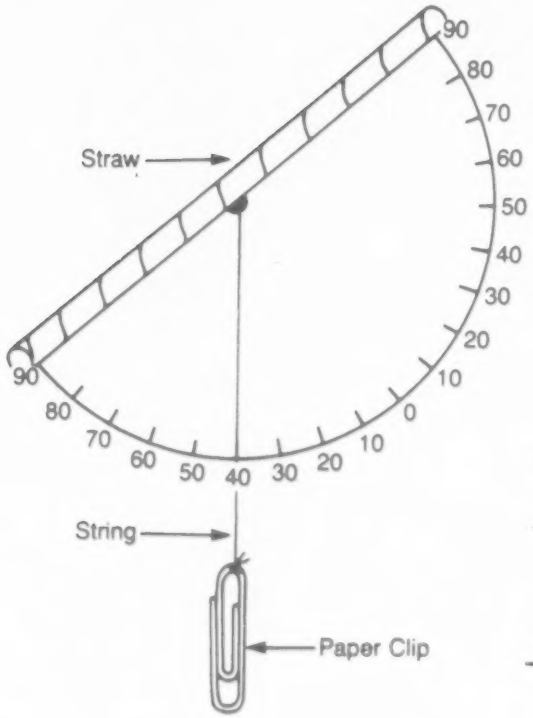
3. Construct $\overline{XY} \perp \overline{AB}$ at y

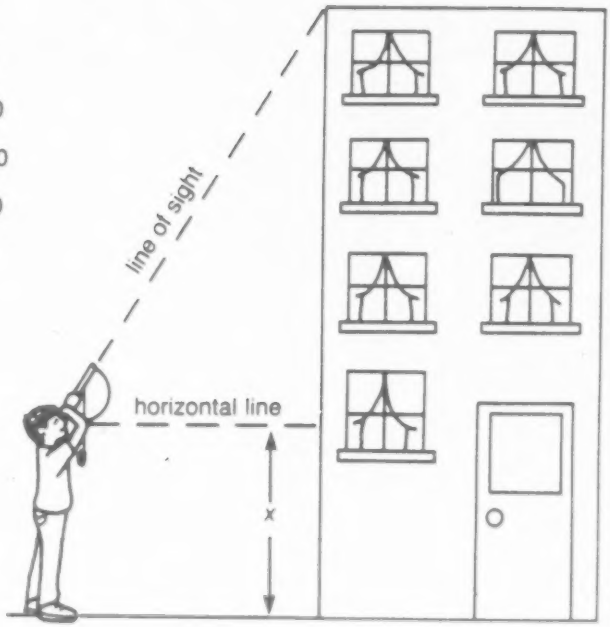
4. Construct $\overline{XY} \perp \overline{AB}$



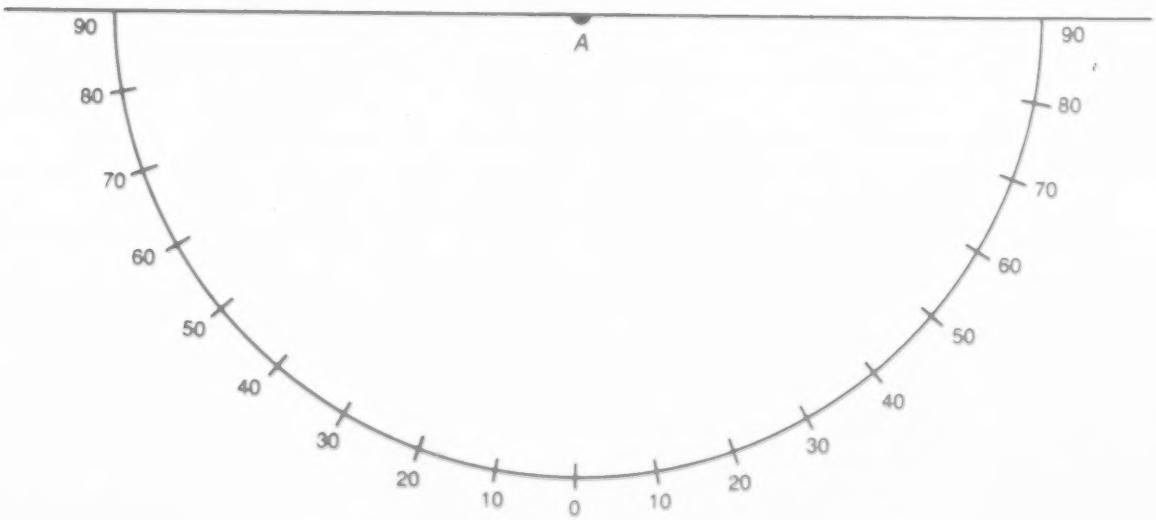
Transparency Master I

Hypsometer





Place on the edge of the index card.



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Activity 12 Teacher Instructions Trigonometry

Use with Lesson 8-5

Objective

To use indirect measurement as an application of trigonometric functions.

Materials Needed

Classroom set of Activity 12 Worksheets
Transparency Master I, p. 106
Transparent tape
Kite string
Protractor, 5" x 7" index card, straw, paper clip, and scientific calculator for each pair of students
Overhead projector

Preparation

Assemble a model of the hypsometer, according to the instructions on Transparency Master I.

Implementation

1. Display Transparency Master I on the overhead projector. Show students the model made during the Preparation step.

2. Have pairs of students assemble hypsometers as shown on the transparency, making sure the string hangs freely to create a plumb line. Use copies of the protractor model at the bottom of the transparency if protractors are not available.

3. Have students practice finding a horizontal line of sight, and reading the hypsometer angle of inclination.

4. Have students use the following to solve for the height of an object:

$$\tan(\text{angle sighted}) = \frac{\text{height of object} - x}{\text{distance to object}}$$

where x represents the distance from the ground to a person's eye level.

5. Have students complete questions 1-2 on the worksheet.

6. Go outdoors, and have students complete the worksheet.

Extension

Use other measuring tools, such as a transit, a compass, or other surveying equipment, to facilitate indirect measurements.

Answers to Worksheet

1. approximately 15.5 feet **2.** approximately 19.3 meters **3.-10.** Answers will vary.

Answers to Independent Activity

1. 1 **2.** 90° **3.** none **4.** none **5.** 45° **6.** 1 **7.** sin A = 0.8000, cos A = 0.6000, tan A = 1.3333, sin B = 0.6000, cos B = 0.8000, tan B = 0.7500, $\angle A = 53.1°$, $\angle B = 36.9°$ **8.** sin A = 0.9231, cos A = 0.3846, tan A = 2.4000, sin B = 0.3846, cos B = 0.9231, tan B = 0.4167, $\angle A = 67.4°$, $\angle B = 22.6°$ **9.** sin A = 0.7071, cos A = 0.7071, tan A = 1, sin B = 0.7071, cos B = 0.7071, tan B = 1, $\angle A = 45°$, $\angle B = 45°$ **10.** sin A = 0.2800, cos A = 0.9600, tan A = 0.2917, sin B = 0.9600, cos B = 0.2800, tan B = 3.4286, $\angle A = 16.3°$, $\angle B = 73.7°$

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TRIG
SINE AND COSINE GRAPH PROJECT

Materials: 1 piece of graph paper
pencil
protractor (provided in class)
ruler with cm
2 small pieces of different color ribbon
1 piece of long paper

Procedures:

PART 1: SINE CURVE $y = \sin x$

1. Trace around the protractor on the piece of graph paper (to represent a unit circle).
2. Fold the paper to find the center of the circle and the origin.
3. Draw the x and y axes on the circle on the graph paper.
4. Using the protractor, mark off and label arc lengths of 15°($\frac{\pi}{12}$ radians) around the entire circle.
5. On the long paper, draw a vertical axis at the left side of the paper and a horizontal axis through the middle of the paper. Make marks on the horizontal axis at 1 cm intervals and label the scale with each unit equal to 15°($\frac{\pi}{12}$ radians). $0° \leq \theta \leq 720°$ and $0° \leq \theta \leq 4\pi$ (label with both degree and radian measures)
6. One of the partners should use one color of ribbon to represent the x-value, and the other partner should use the other color to represent the y-value.
7. On the unit circle, the "x" partner should lay the x ribbon from the origin to the point (1,0) and the "y" partner should lay the y ribbon at 0°and measure the y distance from the 0° mark to the x-axis.
8. The y partner should then mark the one point on the long paper to represent the point y distance at the 0° mark.
9. Then on the unit circle, the "y" partner should lay the y ribbon from the first 15° mark perpendicular to the x-axis. At the same time, the "x" partner should lay the x ribbon from the origin to the point where the y ribbon meets the x-axis.
10. The y partner should then mark the one point on the long paper to represent the point y distance at the 15° mark.
11. Continue this procedure until the graph is completed to 720°, connecting the points as you go.
12. Do not forget the negative values of y.

PART 2: COSINE CURVE $y = \cos x$

1. On the same graph, using steps 6 - 12, make a cosine curve.
2. Now the x partner marks the one point on the long paper to represent the point x length each degree/radian mark.
3. Based on previously known facts, label the coordinates on the y axis at the curves' maximum and minimum points

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TRIG
SINE AND COSINE GRAPH PROJECT

NAME_____

PARTNER'S NAME_____
HOUR_____

PART 3 Evaluation Answer the following questions. (2 points per blank)

1. What is the maximum value of sin θ? _____ of the cos θ? _____

2. What is the minimum value of the sin θ? _____ of the cos θ? _____

3. Name all the degree measures and their equivalent radian measures:
   a. where the maximum value of sine curve occurs._____
   b. where the minimum value of sine curve occurs._____
   c. where the maximum value of cosine curve occurs._____
   d. where the minimum value of cosine curve occurs _____

4.. In your opinion, how does the sine curve compare to the cosine curve? (similarities, differences, etc.)

5. If the sine curve could be picked up and moved left or right to match the cosine curve, which way should it be moved and how far?

6. Name all the degree measures and their equivalent radian measures:
   a. where the sine curve crosses the x axis_____
   b. where the cosine curve crosses the x axis_____

7. How many degrees does one complete cycle of the sine curve take? _____

8. If you were to make a quick sketch of the sine curve by picking 5 ordered pairs, what would they be?

9. If you could pick 5 ordered pairs to sketch the cosine graph, what would they be?

10. Why did the "y" length represent the sine and the "x" length represent the cosine for any given degree?

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Trigonometry Project
Due: Wednesday November 26, 1997

You may choose to write a paper and give a presentation or create a picture using trig graphs. Each project will be worth 50 points.

PAPER and PRESENTATION

Write a one and one-half to two page paper highlighting a career that uses mathematics. This must be double spaced and font size 12. A separate paper listing the two sources must be included. One of the sources may be an interview with a professional in your chosen field. This project will include a report to the class on the day the project is due.

Grading Rubric

(15 pts) Good explanation of career

(15 pts) Math used in career explained in detail

(10 pts) Oral report to the class

(5 pts) Appropriate number of sources

(5 pts) Clearness of content

PICTURE USING TRIG GRAPHS

Create a picture using trig functions and their limitations. Your design must include eight or more equations. A rough draft must be included that will show the full trig curves with no limitations. Add color and creativity to make your design a work of art. This project must be completed on poster board in the following manner.

	Rough Draft	Final
Poster Board	Equations and Limitations	Creation

Grading Rubric

(20 pts) Correct equations and limitations

(10 pts) Rough draft with full curves

(10 pts) Appropriate number of equations

(5 pts) Use of color and creativity

(5 pts) Neatness

SOHCAHTOA
(Sung to the tune "Oklahoma")

SOHCAHTOA where we de-find sine, cos, and tan.
And the ra-ti-os of each of those follow let-ters S, C, and T.
SOHCAHTOA opp-a-sit on hypotenuse is sine.
And for co-sine oh, it's the ra-ti-o
of ah-jay-cent on hy-po-ten-use!
We know we can not forget tan, it's the opp-o-site on ad-jay-san.
And when we say LABEL YOUR SIDES, a trig-o-nom-e-try,
We're only saying, "Thanks for your help SOHCAHTOA!"
SOHCAHTOA, S-O-H-C-A-H-T-O-A
SOHCAHTOA, okay!

I'm Dreaming of a Quadratic

tune: I'm Dreaming of a White Christmas

- I'm dreaming of a quadratic, just like the one in our textbook,
- Where solutions caper across the paper,
- And make me think I'm smart.
- I'm dreaming of a quadratic
- And to myself each night I write:
- May quadratics give you no fright
- And may all the answers be right.

Zero, the Funny Cipher

tune: Ruldolph the Red-Nosed Reindeer

- Zero, that funny cipher, has a shape that looks like 'O',
- And if you want to use it, there are things you need to know.
- Never divide by zero; If you do you will be sad,
- Getting a crazy answer, making your report look bad.
- But treat zero as your friend--use him carefully
- Safe to multiply or add
- That's the rule for zero, lad!
- Zero, that screwball number wants to be a comrade true,
- But never divide by zero, OR YOU'LL BE GETTING ZERO, TOO!

O Geometry

tune: O Christmas Tree

- O G'ometry, geometry, I have a fearful fear of thee!
- Geometry, my bugaboo, A subject I will neer get through.
- You keep my brain in dizzy whirls,
- You're tough for boys, and worse for girls;
- Oh G'ometry, geometry, What Satan's imp invented thee?

http://www.richland.edu/...

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GEOMETRY 1 PROJECT
Due Friday, December 19, 1997
50 points

COLLAGE AND LIST

The project will include two things:

1. A large poster-sized collage. (22" by 28" poster board)
2. A list of geometry terms found in the collage.

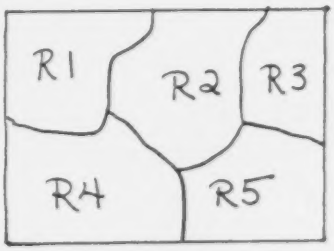
THE COLLAGE

1. Use a 22" by 28" poster board.
2. Cut out pictures from magazines, newspapers, etc. that contain anything that you think deals with geometry and glue these onto the poster board.
3. Cover the entire board. There should be NO gaps.
4. You may do detail work. (Outline in marker, etc.)
5. If you think of a different, creative, way to do the collage, ask me and I will probably let you use your idea. (For example, 3-dimension)

THE LIST

1. The list must include at least 25 terms. (Spelling is important.)
2. The list must by TYPED and on a separate sheet of paper.
3. Include the region, work, and an explanation.

For example,



REGION 1

1. collinear points – the members in the band are collinear
2. triangle – the roof of the house makes a triangle
3. cylinder – the soup can

REGION 2

1. circle – the button on the shirt
   (etc.)

Geometry Collage NAME _____

The project was graded with the following points in mind:

	Possible Points	Earned Points
1. Were 25 different mathematical words listed?	25	
2. Was the list typed and easy to follow?	8	
3. Was the project neatly done?	5	
4. Poster: no gaps/correct size	4	
5. Clearly defined regions on the collage	4	
6. Artistic merit / pleasing to the eye	2	
7. Were the regions listed or diagrammed?	2	
TOTAL	50	

TRIANGLE POSTER

The group will assign roles among themselves and then complete the index card with the name of the person who will assume each role.

Roles: a. Note taker and labeler
b. Triangle maker
c. Checker
d. Printer

INSTRUCTIONS

a. From a piece of construction paper, the triangle maker should cut out the type of triangle named on the index card.

b. Make a poster using a piece of newsprint about your triangle.

c. Put on the poster:
1. Title
2. The triangle cut out of construction paper
3. A list of characteristics of your triangle
4. A list of places where your type triangle is seen in the real world
5. Labels for the vertices
6. Measurements of the sides of the triangle written by each side

d. The checker should check for accuracy and correctness of spelling and measurements.

DATE: _____

STUDENT JOURNAL ENTRY

What idea or concept was made clearer by the review? Explain.

_____

SIGNATURE

DATE: _____

STUDENT JOURNAL ENTRY

I had a good experience in math when _____. (Explain.)

_____

SIGNATURE

DATE: _____

STUDENT JOURNAL ENTRY

Explain the difference between the two laws of deductive reasoning.

_____

SIGNATURE

PORTMANTEAU

1. Divide the class into groups of 4 or 5.

2. Distribute a portmanteau word card to each member in a group. Allow time for members to look up the definition of their word and to write it on the back (blank side) of their card. Each student should then draw a picture of their definition to serve as a memory and teaching aid for their group members. This drawing should be done on the card under the title.

3. When all students are ready, each member will take a turn to teach their group his/her word using their visual aid (drawing). It is the member's responsibility to make sure everyone in their group can say the definition correctly!

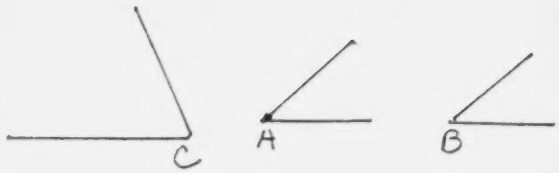
4. After last student has finished, each group member, one at a time, should hold up their card with the picture and word side showing and check to see if all other members can define it! When all can define all words, raise hands. The teacher will come over and randomly quiz each member orally. If all students can answer correctly, points will be awarded to the group. If all students are not able to answer correctly, the group members will be encouraged to HELP each other get the words memorized! This is a group activity - Please help each other! No points will be awarded after the bell rings.

BEST COPY AVAILABLE

A	B
1. adjacent angles	1. oppcsite rays
2. angle bisector	2. perpendicular lines
3. complementary angles	3. supplementary angles
4. congruent segments	4. vertical angles
5. linear pair	5. right angle
6. midpoint	6. straight angle

1. GIVEN: <A and <C are complementary
<B and <C are complementary

PROVE: <A ≅ <B



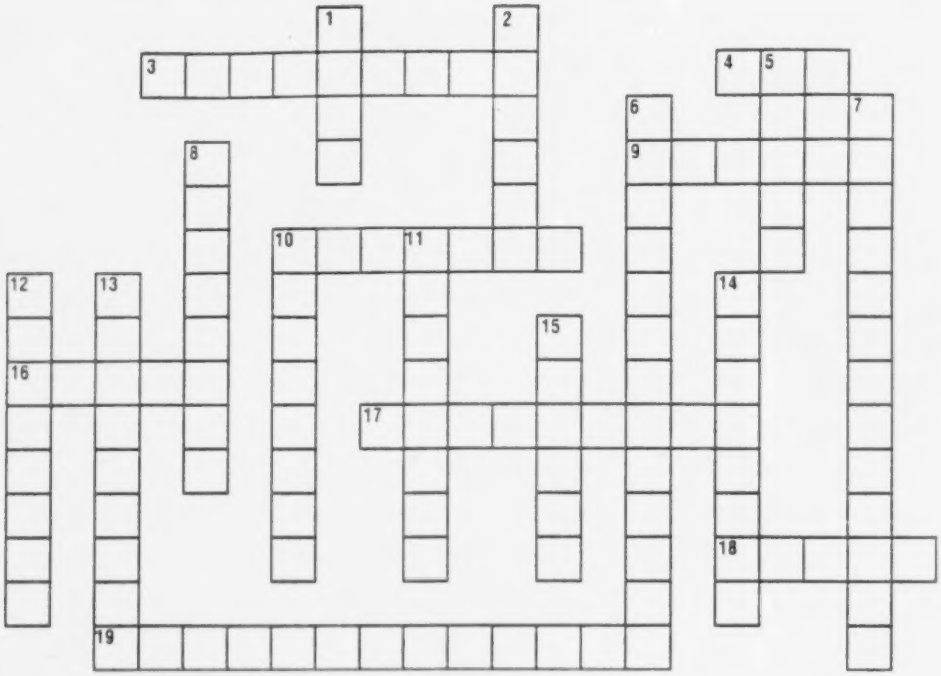
<A and <C are complementary <B and <C are complementary	Given
<A + <C = 90 <B + <C = 90	Definition of complementary angles
<A + <C = <B + <C	Substitution or Transitive
<A = <B	Subtraction Prop. of =
<A ≅ <B	Definition of ≅ angles

1-9

NAME _____ DATE _____

Enrichment Worksheet

Geometry Crossword Puzzle



ACROSS

3. Points on the same line are _____.
4. A point on a line and all points of the line to one side of it.
9. An angle whose measure is greater than 90.
10. Two endpoints and all points between them.
16. A flat figure with no thickness that extends indefinitely in all directions.
17. Segments of equal length are _____ segments.
18. Two noncollinear rays with a common endpoint.
19. If m $\angle A$ + m $\angle B$ = 180, then $\angle A$ and $\angle B$ are _____ angles.

DOWN

1. The set of all points collinear to two points is a _____.
2. The point where the x- and y-axis meet.
5. An angle whose measure is less than 90.
6. If m $\angle A$ + m $\angle D$ = 90, then $\angle A$ and $\angle B$ are _____ angles.
7. Lines that meet at a 90° angle are _____.
8. Two angles with a common side but no common interior points are _____.
10. An "angle" formed by opposite rays is a _____ angle.
11. The middle point of a line segment.
12. Points that lie in the same plane are _____.
13. The four parts of a coordinate plane.
14. Two nonadjacent angles formed by two intersecting lines are _____ angles.
15. In angle ABC, point B is the _____.

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Glencoe Division, Macmillan/McGraw-Hill

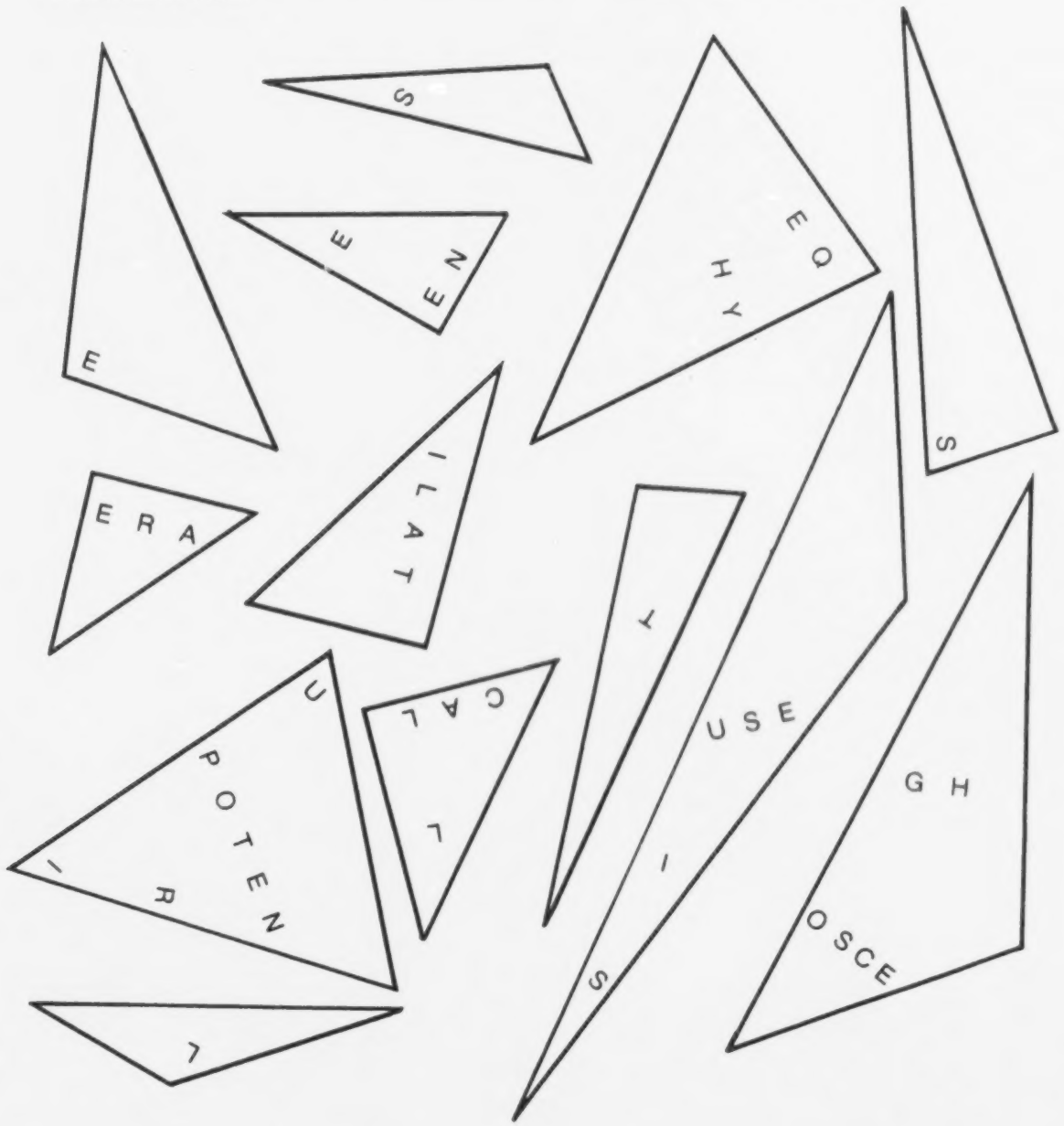
TRIANGLE JIGSAW PUZZLE

Name _____

Date _____

Directions: Cut out the triangles below. Piece them together to form one large triangle. If your work is correct, you will find on the large triangle five words that are used when talking about triangles.

CHALLENGE: On a separate piece of paper, list the five words you find and define each.



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